Republic of South Africa

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SANS 10021 (2012) (English): The waterproofing of buildings (including damp-proofing and vapour barrier installation)

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ISBN 978-0-626-26901-2

SANS 10021:2012
Edition 3.3

SOUTH AFRICAN NATIONAL STANDARD

The waterproofing of buildings (including damp-proofing and vapour barrier installation)

Published by SABS Standards Division
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Table of changes

Change No.	Date	Scope
Amdt 1	2002	Amended to update referenced standards.
Amdt 2	2006	Amended to change the scope, to update referenced standards, to add definitions for acceptable and concrete, to modify the definitions for drying shrinkage, shrinkage during hardening, and solid wall, and to renumber the definitions accordingly, to change the requirements for waterproofing and damp-proofing, basement and semi-basement waterproofing, structural floors and walls, mastic asphalt to basement floors, durability of concrete, formwork, and floor slab construction, to delete the table on minimum recommended ground floor slab constructions (table 1), to change the requirements for polyolefin damp-proof membranes for surface beds, to modify the subclauses on mastic asphalt finishes (6.1.7) and bitumen emulsion-cement finishes (6.1.8), to change the requirements for ceiling compounds for joints, to correct a reference to a figure, to change a common cement type from portland cement to CEM 1, to change the strength type in mix proportions, to change the requirements for water repellents for masonry protection, rain resistance of walls, and compatible paint coatings, to delete the figure of an example of suspended timber floor construction (figure 17), to delete the annex on thatched roofs (annex A), and to correct a reference in the bibliography.
Amdt 3	2012	Amended to update referenced standards, to delete a reference to an asbestos-based product, and to correct cross references.

Foreword

This South African standard was approved by National Committee SABS SC 59J, *Construction standards – Waterproofing membranes, films and barrier products for construction purposes,* in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This document was published in March 2012.

This document supersedes SANS 10021:2006 (edition 3.2).

A vertical line in the margin shows where the text has been technically modified by amendment No. 3.

Annex B is for information only. **Amdt 2**

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The waterproofing of buildings (including damp-proofing and vapour barrier installation)

1 Scope

This standard covers methods recommended for the damp-proofing and waterproofing of buildings and the installation of vapour barriers. **Amdt 2**

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

2.1 Standards

BS 8204-5, *Screeds, bases and in situ floorings – Part 5: Mastic asphalt underlays and wearing surfaces – Code of practice.*

BS EN 1992-3*, Eurocode 2 – Design of concrete structures – Liquid retaining and containing structures.* **Amdt 3**

Amdt 1
EN 485-1, *Aluminium and aluminium alloys – Sheet, strip and plate – Part 1: Technical conditions for inspection and delivery.* **Amdt 1**

EN 485-2, *Aluminium and aluminium alloys – Sheet, strip and plate – Part 2: Mechanical properties.* **Amdt 1**

EN 485-3, *Aluminium and aluminium alloys – Sheet, strip and plate – Part 3: Tolerances on dimensions and form for hot-rolled products.* **Amdt 1**

EN 485-4, *Aluminium and aluminium alloys – Sheet, strip and plate – Part 4: Tolerances on shape and dimensions for cold-rolled products.* **Amdt 1**

EN 515, *Aluminium and aluminium alloys; wrought products; temper designations.* **Amdt 1**

EN 573-1, *Aluminium and aluminium alloys – Chemical composition and form of wrought products – Part 1: Numerical designation system.* **Amdt 1**

EN 573-2, *Aluminium and aluminium alloys – Chemical composition and form of wrought products – Part 2: Chemical symbol based designation system.* **Amdt 1**

EN 573-3, *Aluminium and aluminium alloys – Chemical composition and form of wrought products – Part 3: Chemical composition and form of products.* **Amdt 1;**

EN 1172, *Copper and copper alloys – Sheet and strip for building purposes.* **Amdt 1**

EN 12588, *Lead and lead alloys – Rolled lead sheet for building purposes.* **Amdt 1**

SANS 92, *Bituminous roofing felt*.

SANS 187, *Butyl rubber sheet (for waterproofing)*.

SANS 227, *Burnt clay masonry units*.

SANS 248 , *Bituminous damp-proof courses*.

SANS 297, *Mastic asphalt for roofing*.

SANS 298, *Mastic asphalt for damp-proof courses and tanking*.

SANS 317, *Industrial bitumens*.

SANS 457-2, *Wooden poles, droppers, guardrail posts and spacer blocks – Part 2: Softwood species*. **Amdt 1**

SANS 457-3, *Wooden poles, droppers, guardrail posts and spacer blocks – Part 3: Hardwood species.* **Amdt 1**

SANS 580, *Chloroprene rubber sheet (for waterproofing)*.

SANS 794, *Aggregates of low density*.

SANS 952, *Polymer film for damp-proofing and waterproofing in buildings*. **Amdt 3**

SANS 1090, *Aggregates from natural sources – Fine aggregates for plaster and mortar.*

SABS 1200 GE, *Standardized specification for civil engineering construction – Part GE: Precast concrete (structural)*. **Amdt 1**

SANS 1215, *Concrete masonry units*.

SANS 3575/ISO 3575, *Continuous hot-dip zinc-coated carbon steel sheet of commercial and drawing qualities.* **Amdt 2; amdt 3**

SANS 4998/ISO 4998, *Continuous hot-dip zinc-coated carbon steel sheet of structural quality.* **Amdt 2**

SANS 5836, *Effect of fine and coarse aggregate on the shrinkage and expansion of cement: aggregate mixes (mortar prism method)*. **Amdt 1**

SANS 5863, *Concrete tests – Compressive strength of hardened concrete.* **Amdt 1**

SANS 10043, *The installation of wood and laminate flooring*.

SANS 10070, *The installation of resilient thermoplastic and similar flexible floor covering materials*.

SANS 10073,, *The safe application of masonry-type facings to buildings*.

SANS 10082, *Timber buildings*.

SANS 10100-1 (SABS 0100-1), *The structural use of concrete – Part 1: Design*.

SANS 10100-2 (SABS 0100-2), *The structural use of concrete – Part 2: Materials and execution of work*.

SANS 10109-1, *Concrete floors – Part 1: Bases to concrete floors*.

SANS 10109-2, *Concrete floors – Part 2: Finishes to concrete floors*.

SANS 10160 (all parts), *Basis of structural design and actions for buildings and industrial structures.* **Amdt 3**

SANS 10237 (SABS 0237), *Roof and side cladding*.

SANS 10249, *Masonry walling*.

SANS 10313, *Protection against lightning – Physical damage to structures and life hazard* **Amdt 2; amdt 3**

SANS 10400 (SABS 0400), *The application of the National Building Regulations*.

SANS 10407, *Thatched roof construction.* **Amdt 2**

SANS 50197-1/EN 197-1, *Cement – Part 1: Composition, specifications and conformity criteria for common cements*. **Amdt 1**

SANS 50413-1/EN 413-1, *Masonry cement – Part 1: Composition, specifications and conformity criteria*.

2.2 Other publications

American Concrete Institute. *Manual of concrete practice*. Parts 1 to 5. **Amdt 2**

Basson JJ. *Deterioration of concrete in aggressive waters – Measuring aggressiveness and taking counter measures*. Cement and Concrete Institute. **Amdt 2**

BRE, *Concrete in aggressive ground – Part 1: Assessing the aggressive chemical environment*. BRE Special Digest 1. **Amdt 2**

Building Technology (CSIR). *BOU/E 9602*.

Concrete Manufacturers Association. *Detailing of concrete masonry*. **Amdt 2**

Concrete Manufacturers Association. *Concrete masonry manual*. **Amdt 2**

Fulton's concrete technology. Cement and Concrete Institute. **Amdt 2**

The Clay Brick Association. *Technical guides Nos. 1 to 4*.

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1
acceptable
acceptable to the authority administering this standard, or to the parties concluding the purchase contract, as relevant **Amdt 2**

3.2 **Amdt 2**
adhesive (hot applied or cold applied)
a material that is applied either hot or cold (as relevant to the material), to stick membranes together or to underlying structures, or to weld them together

3.3 **Amdt 2**
asphalt
a mixture of bitumen with inert mineral matter

3.4 **Amdt 2**
asphaltic compound
a compound that is based on bitumen and inert filler, i.e. a type of asphalt

3.5 **Amdt 2**
basement
the lowest part of a structure, below natural ground level

3.6 **Amdt 2**
bitumen
a non-crystalline solid or viscous mixture of complex hydrocarbons that possesses characteristic agglomerating properties, that softens gradually when heated, that is substantially soluble in carbon disulfide, and that is found in association with mineral matter as a component of naturally occurring asphalt, or is obtained by a refinery process from petroleum or oil shale

3.7 **Amdt 2**
bitumen emulsion
a system in which particles of bituminous material are dispersed in water

3.8 **Amdt 2**
bituminous
containing bitumen or constituting the source of bitumen

3.9 **Amdt 2**
bituminous compound
a mixture of bituminous binder and filling material that has properties that render it suitable for special application (The term is usually qualified by an adjective that describes its use, e.g. bituminous jointing compound.)

3.10 **Amdt 2**
black sheathing felt
a coarse felt that is impregnated, but not coated, with tar or bitumen

3.11 **Amdt 2**
bond
<in masonry wall construction> a systematic arrangement of building units in the wall, usually in courses, in which the overlapping of the units ensures that they will act together as a whole under load

3.12 **Amdt 2**
bricks
<for the purpose of constructing a damp-proof course> burnt clay masonry units that are well vitrified and therefore of low water absorption

3.13 **Amdt 2**
capillary action
the ability of liquids to rise in fine capillaries or tubes, against the force of gravity, owing to surface tension. In the context of this document, the ability of water to rise through subsoil in the fine soil pores that create tubes or bores in the upward passage of the water

3.14 **Amdt 2**
caulking compound
a compound that is applied under pressure to seal a confined space or void against the passage of moisture

3.15 **Amdt 2**
cavity wall
a wall that consists of two separate walls (called leaves) of either solid or hollow units that are built side by side and so tied to each other with wall ties that a cavity of at least 50 mm in width is formed between the leaves

3.16 **Amdt 2**
cement mortar
an hydraulic mortar in which portland cement or a portland cement blend or masonry cement is used as the binding agent

3.17 **Amdt 2**
coated felt
a felt that is coated on both sides with bitumen-based compound

3.18 **Amdt 2**
concrete
composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregate, usually a combination of aggregate and coarse aggregate

NOTE In portland-cement concrete, the binder is a mixture of portland cement and water, with or without admixtures. **Amdt 2**

3.19 **Amdt 2**
condensation
the result of the change of state of diffused water vapour into its liquid state (It can occur permanently or intermittently, on exposed surfaces or interstitially.)

3.20 **Amdt 2**
coping
a unit or assemblage that is placed at the head of a wall and that is designed to shed rainwater from the top of the wall clear of all exposed faces of the walling it is intended to protect

3.21 **Amdt 2**
copper
a ductile, corrosion-resistant metal that is capable of being formed into thin sheets tempered to varying degrees of hardness, and sometimes used as flashing or as a damp-proof course in buildings

3.22 **Amdt 2**
cut-back bitumen
a bitumen of which the viscosity is adjusted by the addition of a volatile solvent

3.23 **Amdt 2**
damp-proof
proof against the transmission of moisture in liquid or vapour form

3.24 **Amdt 2**
damp-proof course
DPC
a damp-proof material that is applied within or on a construction, to prevent the passage of moisture. Damp-proof courses are usually horizontal layers within masonry walling

3.25 **Amdt 2**
damp-proof membrane
DPM
a sheet material or a film-forming liquid that is applied to a horizontal or vertical surface, to prevent the passage of moisture

3.26 **Amdt 2**
dew point
the temperature at which the air cannot hold any more water in the vapour state

3.27 **Amdt 2**
drip groove; throating
a groove that is formed in the soffit of an exposed building element and is designed to throw off rain water and to prevent it from being drawn inwards along the underside by surface tension

3.28 **Amdt 2**
drying shrinkage
the difference between the length of a specimen that has been saturated with water and its length after drying to a constant length, under specified temperature and humidity conditions, and expressed as a percentage of the dry length (see SANS 297 and SANS 298) **Amdt 2**

3.29 **Amdt 2**
facing
the outermost part of a wall, when it is composed of different materials or different grades of material and is held on the part below (i.e. the backing) by bonding or mechanical anchors, or both

3.30 **Amdt 2**
felt
a material that is "felted" by interlocking the fibres, pressed, and then cut into sheets

3.31 **Amdt 2**
flashing
a strip of impervious material, fixed and dressed to a building to cover an intersection or joint between two surfaces where water would otherwise penetrate

3.32 **Amdt 2**
granular layer
a layer of natural aggregate or crusher-run aggregate from which the fine fractions have been specifically screened and excluded and that is used either under the ground floor slab to reduce the upward movement of water by capillary action, or as a thermal barrier or topping in a composite roof-slab construction

3.33 **Amdt 2**
hardcore
a layer of stones, hard-burnt brick or broken concrete, without fines, and that is used to prevent the rise of moisture through capillary action whilst forming a base for the ground floor construction

3.34 **Amdt 2**
hardness number
a measure of the resistance to indentation of a mastic asphalt, as determined by the methods described in SANS 297 and SANS 298

3.35 **Amdt 2**
impregnated felt
a felt that is saturated with bitumen or tar

3.36 **Amdt 2**
joint sealing compound
a material that is used by itself or in conjunction with mortar or other material for making joints watertight

3.37 **Amdt 2**
lead
heavy soft grey ductile metal that is capable of being formed into sheets and that is used as a damp-proof course or bent and dressed as flashing (It is sometimes alloyed with tellurium to increase its strength.)

3.38 **Amdt 2**
leaf
<of cavity wall> the wall construction on one side of a cavity

3.39 **Amdt 2**
masonry
an assembly of building units that are usually laid in mortar and so arranged as to be bonded together

3.40 **Amdt 2**
mastic asphalt
a type of asphalt that contains mineral matter suitably graded to form a coherent voidless impermeable mass that is solid or semi-solid under normal temperature conditions, but that, when heated, is fluid enough to be spread by means of a hand float

3.41 **Amdt 2**
membrane; waterproof; damp-proof
a thin flexible sheet that forms a lining or a damp-proof, waterproof or vapour barrier to rising or penetrating damp or condensation

3.42 **Amdt 2**
moisture movement
the change in length that occurs upon either wetting or drying of a mature building unit (The term covers both wetting expansion and drying shrinkage.)

NOTE 1 Although the term has been used both in this sense and to mean only wetting expansion, in this standard it is used to cover changes in length owing both to wetting and drying.

NOTE 2 This definition applies to building units and parts of buildings where cement has been used, and is best understood when read together with the definitions of "wetting expansion", "drying shrinkage" and "shrinkage during hardening".

3.43 **Amdt 2**
mortar
a plastic mixture that gradually hardens, is composed of cementitious materials, sand and water in certain proportions, and is used for the bedding and jointing of masonry units and other construction components in a building

3.44 **Amdt 2**
mortar types
specific mixes for specific uses as stated in table 5 of SANS 10249 and designated as classes I, II and III

3.45 **Amdt 2**
no-fines concrete
a concrete that is composed only of coarse aggregate, cement and water

3.46 **Amdt 2**
penetrating dampness
dampness in a structure that is caused by the ingress of external moisture

3.47 **Amdt 2**
polyolefins
<mainly polyethylene> hydrocarbon polymers that are made from unsaturated hydrocarbons (mainly ethylene, but also propylene) and that are compounded with suitable fillers to form flexible impervious sheets that are suitable for use as damp-proof courses and damp-proof membranes

3.48 **Amdt 2**
primer
a cut-back bitumen that is used to prepare a surface for the operation that is to follow

3.49 **Amdt 2**
ridge line
<in flat roof construction> the line of apex of roof slopes

3.50 **Amdt 2**
rubberized cement
an adhesive that contains rubber or that has rubber-like properties

3.51 **Amdt 2**
run-off line
<in flat roof construction> the valley line of slopes of different directions

3.52 **Amdt 2**
separation cracking
cracks that are formed by the separation of the faces of building units and the mortar, and that result in capillary paths

3.53 **Amdt 2**
shrinkage during hardening
the shrinkage that occurs when a freshly made concrete mortar or plaster unit or a masonry unit based on portland cement or portland cement blend, matures and dries (This shrinkage is usually larger than any subsequent moisture movement.) (See also note 2 to 3.42.) **Amdt 2**

3.54 **Amdt 2**
slate
natural stratified metamorphic rock cleaved and fashioned to a thickness of not less than 4 mm, and that can be used for the purpose of forming a damp-proof course

3.55 **Amdt 2**
solid wall
a wall that is constructed without a cavity and with all joints fully filled with mortar **Amdt 2**

3.56 **Amdt 2**
solvent
a volatile diluent (Some types of solvent are used to decrease the viscosity of bitumens and others to provide a temporary surface change on polyolefin membrane materials in order to facilitate a physical bond or weld.)

3.57 **Amdt 2**
tanking
a waterproof membrane that is laid beneath the basement floor and up the outer face of the basement structural walls (It is usually protected against the backfill material.)

3.58 **Amdt 2**
valley line
the line of intersection of two adjacent roof slopes towards each other

3.59 **Amdt 2**
vapour barrier
an impervious barrier that prevents the passage of water vapour through building components (as from a warm space to a cooler surface, where dew formation might occur)

3.60 **Amdt 2**
veneer
a relatively thin facing, usually attached to the backing without the use of a masonry bond

3.61 **Amdt 2**
wall ties
regularly spaced connectors between the two leaves of a cavity wall, that are configured to prevent the passage of water across the cavity (They should be corrosion resistant and are usually galvanized steel or stainless steel.)

3.62 **Amdt 2**
waterproof
impervious to water under an hydrostatic head

3.63 **Amdt 2**
water-resistant construction
a construction that has a lower degree of resistance to moisture penetration than a waterproof construction

3.64 **Amdt 2**
wetting expansion
the expansion that occurs when a dry mature building unit is wetted (Standard test methods to measure the amount of expansion are laid down in SANS 1215. See also note 2 to 3.42.) **Amdt 2**

3.65 **Amdt 2**
zinc
a silvery, malleable metal, normally alloyed to give creep resistance (e.g. zinc-titanium alloy), that can be formed into thin sheets and placed in a wall construction to provide a damp-proof course, or that can be bent or dressed to profile (or both) to provide a waterproof flashing

4 Waterproofing and damp-proofing

4.1 Introduction

Water will cause serious and continuing problems in buildings and building materials unless its effect is understood and provided for in the construction details. It can get into places where it should not be, by running freely or being driven by wind, by pressure, by soakage, by capillary action or by vapour diffusion. It can affect the materials of which the building is constructed, causing unsightly blemishes and progressive decomposition by chemical reaction, rot or resultant insect infestation.

The exclusion of moisture from the interior is usually the basic function of buildings. This can be achieved by correctly detailing, specifying and installing the right waterproofing materials. Dampness and water penetration are associated with poor detailing, poor workmanship, inferior materials or any combination thereof.

A building is subject to a high degree of climatic and occupational exposure and should be able to withstand the elements while continuing to function with the minimum of maintenance of its fabric and finishes.

Foundations might be subject to attack by aggressive ground water conditions and basements might be required to withstand high residual water pressure. Even on what appears to be a "dry site", capillary action can result in ground water rising through an unprotected floor slab to attack the slab, screed-imbedded services and surface finishes.

Bricks (even with low water-soluble salt levels) that are subject to moisture from the surrounding soil, can either effloresce on their surface with unsightly crystallization and spalling, or even more damaging crypto-efflorescence can occur within the body of the brick.

Condensation in roof spaces is all too often a common occurrence, and correct detailing can obviate damage to thermal insulation, ceiling finishes and roof membranes. **Amdt 2**

The material alone is not the main consideration. The best solution lies in correct constructional detailing with waterproofing materials, to ensure that the materials, components and elements in the substructure and superstructure are protected.

4.2 Types of water penetration

4.2.1 Rising-damp capillary action

Water rises progressively through the soil because of capillary action. The parched soil particles form surfaces that effectively provide tubes or capillaries in which the water rises. The narrower the capillary or tube, the higher the water rises. The soil under a building can therefore be regarded as being composed of a very large number of capillary tubes that lead water up to the surface.

If an impervious barrier or a nearly impervious barrier is placed on the surface of the ground, the water from the subsoil will rise and collect on the underside of this barrier. The concrete surface bed of a building forms such a barrier, but concrete cannot be regarded as impervious, and moisture might migrate through the concrete to the underside of the floor finishes.

Even if a site appears to be dry, water is always present to some extent, and the water table varies constantly. Water might evaporate but is also replaced, and as this process continues, water-soluble salts rise with the moisture into unprotected materials and are deposited in these materials, causing chemical reactions and decomposition. Rising damp can occur in any wall and usually leaves a tell-tale tide mark on internal decorations. It rarely reaches more than a metre above floor level.

4.2.2 Penetrating damp

Penetrating damp comes in sideways through walls and is dependent on the exposure given to the building components and on both the inherent and developed absorption and permeability characteristics of the building material(s).

Highly absorptive and permeable masonry can provide an easy path for penetrating moisture.

NOTE Since any masonry wall might eventually allow water to pass through it if the exposure is severe, it is prudent to provide a positive barrier either by employing cavity construction or by incorporating a damp-proof barrier.

Impervious claddings that have cracked or are perforated will allow the ingress of moisture that is likely to penetrate to the interior, causing visible damp staining.

Penetrating damp is usually fairly easy to distinguish from rising damp. It is usually associated with the direction(s) of the prevailing wind or driving rain. Efflorescence and localized staining are generally signs of water penetration. Penetrating dampness can occur where a perfectly good damp-proof course (DPC) is bridged by soil or other materials above the DPC level, or where the ground level falls towards a wall and storm water can dam up against the wall and rise above the DPC.

Penetrating dampness increases the thermal transmittance coefficient values of the wall (the higher the value, the greater the heat loss) and introduces moisture to the internal atmosphere. When the moisture evaporates it causes some cooling, so that it is likely that penetrating dampness and condensation will occur together.

4.2.3 Condensation

Condensation problems are associated with poor thermal insulation, ventilation and heating.

Surface condensation might be permanent or intermittent. Where internal air has a high relative humidity and reaches surfaces with low temperatures, the condensate that will occur is referred to as *permanent condensation*, since it will not re-evaporate at a later date and can be eliminated only if the conditions in the building are altered.

When there is a period of cold weather followed by a sudden warm spell and conditions of high atmospheric humidity, the relative humidity of the air rises quite rapidly so that its dew point becomes higher than the temperature of some surfaces, causing condensation to occur. The warm air conditions will allow the surface temperature to rise gradually until it is higher than the dew point, at which stage the moisture will re-evaporate into the air. This is called *intermittent condensation*. This condition is likely to be the most severe in structures of high thermal capacity that are heated poorly or not at all.

Condensation might occur within a structural element, in which case it is known as *interstitial condensation*. This happens when the temperature gradient is such that the temperature falls below the dew point within a cavity in the structural element to which moisture-laden air can penetrate. Condensation then starts on a surface within the element. If such interstitial condensation occurs, remedial work is difficult.

In order to prevent interstitial condensation within the walls or roof of a building, steps should be taken to prevent the accumulation of moisture vapour within them. Water vapour tends to flow through the structure from the damp warm air inside the building to the cold dry air outside. It is therefore logical to prevent water vapour from passing into the structure. This is achieved by the use of a vapour barrier. Attention should be paid to the sealing of joints if the vapour barrier is provided as an inherent part of the insulation. It is absolutely essential that the vapour barrier be

placed on the warmer side of the insulation to be used. Since insulating layers cause steep temperature gradients, it follows that they will maintain a high temperature on their warm side if they are effective, while they might approach the temperature of the cold outside air on their cold side. It is therefore possible for the dew point to lie within the insulating layer. If the barrier is placed on the cold side of the insulating layer, it will not prevent vapour from penetrating the wall to the dew point plane. It merely serves to inhibit any evaporation of the moisture to the outside, should this at any time be possible. However, if the vapour barrier is installed on the warm side of the insulation, the vapour cannot penetrate to the condensing plane and is contained in the room at conditions above dew point.

The permeability of building materials varies over a wide range. Some materials have a sufficiently high resistance to the passage of water vapour and for most practical purposes can be regarded as water vapour barriers in their own right.

4.2.4 Other forms of water penetration

External leaks from roofs will usually produce localized stains on ceilings. Faulty plumbing, especially if imbedded in walls and floors (a bad practice as far as the differential movement of elements and materials is concerned), could cause water penetration that in turn could give rise to timber rot and widespread problems in brickwork, plaster, and floor and ceiling finishes.

4.3 Moisture movement of materials

Impervious materials such as metals and glass are not subject to moisture movement. The same applies to dense materials such as granitic rock. Many plastics display negligible moisture movement. However, moisture movement does take place in porous materials, in proportion to their moisture absorption coefficient. Many materials, when new, undergo initial irreversible moisture movement, such as irreversible moisture expansion in the case of clay bricks or shrinkage in the case of cementitious products, as a facet of hydration and carbonation, while concrete bricks and blocks undergo a reversible moisture expansion.

When large areas or expanses of work are carried out using materials with varying moisture movement characteristics, expansion joints that are correctly placed, designed and executed are vital. Provision should be made to include suitable means of preventing ingress of moisture through the joints.

In existing structures that are not protected from moisture or water penetration, one often sees crystallization of substances as a result of chemical reaction between materials or between materials and their environment.

Burnt clay products undergo irreversible moisture movement to a greater or a lesser degree, and this movement in, for instance, long lengths of wall or floor tiles, can be quite significant. In the case of floor tiles, a damp-proof membrane not only provides a water barrier but also acts as a slipsheet between the screed and the structural slab, the latter being subjected to initial drying shrinkage and subsequent reversible moisture movement. In such applications the screed should be of substantial thickness to support and hold together the tiled panels.

5 Basement and semi-basement waterproofing

5.1 Introduction

Before work is started on any design of any structure below ground level, a thorough site investigation should be made (including the testing of water samples for sulfides and other aggressive chemicals). (See BRE Special Digest 1.) **Amdt 2**

Semi-basements and basements should be made waterproof by utilizing one or a combination of some of the following: **Amdt 2**

a) employing a waterproof polyolefin membrane, bitumin-based membrane, mastic asphalt or any other suitable waterproofing material that is not covered in this standard, sandwiched between supporting layers of concrete or fully caulked masonry (or both) (see figures 1 to 7);

b) paying special attention to the material specification, density and placing of concrete to render it inherently waterproof (see figures 10 and 11);

c) constructing floors and walls with cavities that are drained to a sump (see figures 8, 12, 13 and 14);

d) reducing lateral water pressure by installing, prior to backfilling, a cut-off trench and land drain or a French drain against the outer skin of the basement walls and draining it to a sump to connect up with the stormwater reticulation (see figures 2 and 14); and

e) reducing the surface water entering adjacent ground by sloping the ground surface away from the building for approximately 3 m. Paving this area will be even more effective.

There are a number of constructional detailing methods that can be used to achieve a waterproof basement. In all cases, the method chosen should be such that the basement is rendered completely waterproof.

Openings for services, pipes, cables, etc., should be avoided when basements are being tanked, but if they are unavoidable, due attention should be paid to details (see figure 9). The structure should be so designed that movement that could damage the waterproofing is avoided. Construction joints should be kept to a minimum and water stops should be provided (see figure 11). Special attention should also be paid to the jointing of waterproofing at columns and corners (see figure 8).

Almost all basement structures will be subjected to water pressure of some sort at some stage. If the spaces below ground level are enclosed, water penetration will inevitably take place through unprotected walls and floors, with all the attendant problems of moisture movement, efflorescence and decomposition of materials by chemical reaction, expansion, mould growth and insect attack.

A semi-basement exists where the floor level is stepped, however slightly, and the vertical surface becomes a wall that retains moist subsoil. A vertical damp-proof membrane is therefore essential to prevent the flow of water through the vertical surface (see figure 1).

The proximity of water supply mains and storm-water, waste-water and soil-water drainage lines or mains should also be carefully considered when basements are designed. It is therefore prudent to provide a waterproof construction. Sound construction depends not only on good detail design and specification but also on the standard of workmanship and supervision. This applies particularly to waterproof construction, where everything possible should be done to ensure the consistent production of good concrete, so that the maximum water resistance is obtained from the materials employed.

5.2 General

5.2.1 Treatment of surface water

Surface water in areas such as courtyards and gardens, and discharges from downpipes from gutters on roofs of buildings adjacent to basements should be controlled and diverted away from basement walls by means of paving, piping, channelling, grass sodding, consolidation of the ground, land drainage and French drains, with falls or gradients to points remote from the basement walls.

5.2.2 Structural floors and walls

All basement construction should be structurally sound and designed to withstand external retained earth and hydrostatic pressures without cracking. The construction should be built of good quality materials, combined with good workmanship and supervision. If concrete is used, it should be designed, correctly placed and effectively cured in such a way that a high degree of homogeneity, limited initial drying shrinkage, strength and low water absorption characteristics are ensured. All construction joints should be carefully designed and executed.

If bricks are used, they should comply with SANS 227 and SANS 1215, be correctly laid with all joints fully buttered up, placed, not slid, into position and be correctly bonded and tied. The bonding mortar should be carefully designed to ensure the correct water/cement ratio, and should be correctly used. Engineering units of compressive strength not less than 25 MPa, with a water-soluble salt content of less than 0,60 % and not more than 8 % water absorption, laid in class I mortar, with the joints of each course grouted solid as the work proceeds, are recommended.

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5.2.3 Ventilation

All basements should be particularly well ventilated.

5.2.4 Pumping

The site should be kept dry at all times until the basement is complete and able to withstand the full water pressure. Before pumping is discontinued, all necessary steps should be taken to ensure that the structure does not float.

5.3 Construction incorporating membranes — General

5.3.1 Introduction

A construction that incorporates a waterproof membrane of bituminous felt, mastic asphalt or polyolefin sheeting as a barrier against the ingress of water under hydrostatic pressure should be correctly designed and the membrane should be carefully installed and protected against damage during construction. Provision should also be made for structural movement in order to obviate sagging and tearing of the membrane.

The membrane should be adequately supported by the construction on both its faces. It is necessary to sandwich the membrane between structural walls, both for protecting it against damage and for ensuring its integrity, since it is not designed to resist water pressure unless so supported.

Plastics and rubber type membranes should comply with the requirements of SANS 187 or SANS 952 and should be laid strictly in accordance with the manufacturer's instructions and design details. Mastic asphalt should comply with the requirements of SANS 298 and bituminous felts should comply with the requirements of SANS 248. Bituminous felts with inorganic bases perform better in damp conditions than do felts with organic bases.

5.3.2 Protection of membranes

Waterproof membranes have to be protected against mechanical damage. The following methods provide protection:

a) In the case of floors, the membrane should immediately be protected against damage from pedestrian traffic, the contractor's plant, wheelbarrows, etc., and no point loading on the membrane should be permitted. A well-tamped layer of sand blinding of thickness at least 50 mm over the compacted sub-base or subgrade (see SANS 10109-2) will protect the membrane from

being punctured from below, and similarly a layer of sand blinding over the membrane will also protect the membrane against damage from above. The concrete floor slab or covering floor should be laid as soon as possible after the membrane has been laid, and the freshly laid concrete should be damp-cured until it has reached sufficient maturity, before any loading, such as shoring, is allowed upon it.

b) Where the membrane is sandwiched between a retaining wall or protecting skin wall and the structural basement wall, it may either be specified, detailed and installed or applied to the outer face of the inside wall or to the inside face of the outer protective skin wall, to protect the membrane and ensure its waterproof integrity. In either case, it is important that it be carefully installed and protected against damage before the secondary wall is constructed. If applied to the outside face of the structural wall (i.e. external tanking), the membrane will have to be protected against backfilling in the space allowed for working. This is often done in brickwork (see figure 2). Permanent shuttering of corrugated fibre cement, with a weak mortar mix filling to the profile and proceeding to a panel height of not more than 900 mm, or alternatives can be used.

The section of basement wall exposed above ground level is usually insulated for exceptionally cold climates (see figures 2 and 3). When the protective wall is of masonry, it is recommended that it be built 20 mm to 30 mm away from the damp-proof membrane and that the cavity be grouted up as the work proceeds, but not by more than three courses at a time. The membrane should at all times be protected against damage from brick arrises, aggregate, nails, etc.

When the waterproof membrane is applied to the internal face of a protective skin wall that is built first (i.e. internal tanking), the skin wall should be capable of resisting the retaining earth and hydrostatic pressure to which it might be subjected until the wall of the inner structure is built and becomes the principal retaining wall (see figures 3 and 6).

This method is employed where no excavation beyond the line of the protective wall is possible, for example when building on the boundary line.

The external skin should be built on a subfloor slab that is designed to temporarily resist hydrostatic pressure until the horizontal damp-proof membrane is brought up to the face of the wall to bond with the vertical waterproofing membrane. The final upper reinforced concrete floor slab that is designed to resist hydrostatic pressure should then be cast, followed by the basement walls.

The protective upper floor slab and internal structural wall should be cast and erected as soon as possible after the horizontal and vertical waterproof membranes have been placed.

5.4 Polyolefin sheet waterproofing membranes

5.4.1 Materials

5.4.1.1 For semi-basement conditions or where hydrostatic pressure levels are minimal, one layer of 500 μm (0,5 mm) polyolefin waterproof sheeting that complies with SANS 952 type C should be used, with all joints and laps made with compatible solvent welds, strictly in accordance with the manufacturer's specifications and instructions.

5.4.1.2 Where hydrostatic conditions are encountered, one layer of 1 000 μm (1,0 mm) polyolefin waterproof sheeting should be used instead.

5.4.2 Polyolefin waterproof sheeting to basement floors

When a polyolefin waterproof sheeting membrane is installed in a basement floor construction, the following points should be observed:

a) The surface on which the polyolefin waterproof sheeting is to be laid should be clean, reasonably level and free from sharp protrusions. The surface might require some levelling with sand

blinding before the sheet is laid, and the sheet should be covered with 20 mm of sand or a layer of building paper before the concrete slab is laid.

b) Where the foundations are to be wrapped to prevent loss of fines from the base or to prevent attack by aggressive ground waters (or both), the layers below the floor slab should be well compacted and, if necessary, top blinded with 20 mm of sand. The waterproof membrane should then be laid into and over the excavations, lapped and jointed and dressed up to the vertical plane for vertical lapping and jointing before being covered with 20 mm of sand or with building paper to protect the waterproofing from site traffic before the slab is laid.

c) The sheets are to be extrusion welded or wedge welded to obtain a waterproof joint, in accordance with the manufacturer's specifications and instructions.

d) Concrete should be carefully laid and arris fillets should be constructed where a concrete structural wall and concrete floor abut, in order to obviate tearing or creasing at the junction. Steel reinforcement should be placed using mortar cubes (made from a 1:1 mix of cement and coarse sand and cured for 7 d), and appropriate plastics spacers or steel chairs. Where wire is used, all tying should be carefully executed, and artisans and labourers should at all times take care not to damage, tear or puncture the waterproof sheet.

e) Before the concrete is placed, the membrane should be carefully examined and, if necessary, be repaired, in accordance with the manufacturer's specifications and instructions. This simple additional supervisory precaution is recommended in order to prevent costly repairs at a later stage. (See figures 1, 2 and 3 for details of typical waterproof polyolefin applications in basement floors.)

5.4.3 Polyolefin waterproof sheeting to basement walls

When waterproof polyolefin sheeting is applied to basement walls, the following points should be observed:

a) All walls to receive waterproof sheeting should be constructed reasonably straight and plumb, and should be free from sharp edges and protrusions, in order to ensure that the sheeting will not be punctured during installation. Concrete supporting walls should be carefully constructed to obviate penetration of the waterproof membrane by reinforcement, anchors, bolts, ties and other protrusions.

   Masonry walls should be free from sharp arrises, protrusions and projecting ties, and uneven surfaces should receive a sand/cement bagged finish.

b) Care should be taken when hanging, positioning, lapping and sealing the waterproof sheeting, which should be supported to prevent vertical deformation. Tuck joints should be provided by forming horizontal chases in the concrete wall to accept battens, strips of rigid polymer or proprietary inserts continuously along the length of the basement walls, or by forming chases of depth at least 50 mm and of width at least 15 mm in the brickwork to accept a proprietary compressible tube as insert. The vertical distance between chases should not exceed 1,5 m. A strip of sheeting should be introduced into the chase, the sheet tucked in and the appropriate insert pressed in to form a friction grip. (See figures 1, 2 and 3 for typical details of using polyolefin waterproofing to basement walls.)

5.5 Mastic asphalt waterproofing

5.5.1 Materials

The mastic asphalt should comply with the requirements of SANS 297 or SANS 298. Mastic asphalt should be of a hardness that will obviate any extrusion owing to pressure by walls.

5.5.2 Mastic asphalt to basement floors

When mastic asphalt is applied to the floor of a basement construction, the following points should be observed:

a) The concrete base on which the asphalt is to be laid should be dry, smooth and clean. A carefully floated or trowelled concrete base is smooth enough not to require a sand cement screed.
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b) An underlay of incompletely saturated felt or of building paper should be used in order to provide a slip or movement sheet to dissociate the mastic asphalt from the base. Such a layer minimizes the danger of the transmission of settlement or moisture movement that might develop in the base, and also provides a dry surface on which to lay the mastic asphalt. It is therefore important that the slab or the screed on which the slip sheet is laid be sufficiently smooth and not contain areas of bonding that prevent free movement of the slip sheet and the mastic asphalt waterproofing.

c) The mastic asphalt should be applied in three layers, the total resultant thickness being at least 30 mm. Alternatively, a two-coat application with a resultant thickness of at least 20 mm may be used.

d) Each coat of mastic asphalt should be so applied in panels that the edges do not coincide with the edges of the other coats or with the joints of the underlay used. Any mastic asphalt work left unfinished should be cleaned and reheated at the edges before fresh material is laid next to it.

e) Thickness gauges should be used for each coat of mastic asphalt. On no account may nails or similar fixings be driven into the undercoats (except into the first or base coat), to fix gauges in position.

f) The details of the junction between the mastic asphalt of the floor and that of the wall vary according to the method of basement construction used. Mastic asphalt fillets should be provided at all internal angles and should be applied in two coats. Care should be taken to ensure that the initial coat is heated and cleaned before the application of the second coat. (See figures 4, 5, 6 and 7 for typical details of mastic asphalt waterproofing used for basement floors.)

5.5.3 Details of mastic asphalt to basement walls

When mastic asphalt is applied to basement walls, the following points should be observed:

a) Although the wall surface should be free from protrusions or pitting, the surfaces should be sufficiently rough to provide a good key for the adhesion of the mastic asphalt. The horizontal bed joints in a masonry wall should be raked out to a depth of approximately 15 mm and the surfaces of the concrete walls scored or scarified to provide indentations of not less than 10 mm and preferably up to 20 mm, after the shuttering has been stripped and the walls have been well brushed to remove laitance and other loose matter. When the mastic asphalt is applied to a skin wall, that wall should be structurally designed to support the retaining earth of the excavation and to resist hydrostatic pressure before the casting of the inner structural wall (see figure 6).

b) The mastic asphalt should be applied in three layers, the total resultant thickness being at least 20 mm. When the area of the walls is such that jointing is necessary, the layers should be so applied that the joints in successive layers do not coincide. Any mastic asphalt left unfinished should be cleaned and reheated to melt and bond with the newly applied surface mastic when work is resumed.

c) Thickness gauges should be used for each layer of mastic asphalt. For the initial base coat layer, the gauges may be fixed to the walls by nails or by other means, but nails should not be used for the other layers and the gauges should therefore be attached with mastic or other suitable adhesive.

d) To prevent water pressure from dislodging the vertical waterproofing layers from behind (through the protective skin wall), the vertical cavity between the waterproofing and the inner skin wall should be filled solid with mortar in the course of construction.

5.6 Bituminous felt waterproofing membranes

5.6.1 Materials

Two layers of bituminous felt that complies with the requirements of SANS 248 or with the requirements of SANS 297, or of equally suitable felt that has a mass of not less than 3 kg/m^2, are the minimum specified for bituminous waterproofing where hydrostatic pressure is known to exist or where it might develop.

When bituminous felts are being selected for this type of construction, it should be borne in mind that type FV of SANS 248 offers better tear resistance than those types with a fibre-felt base, and also that the various types of bases used in the manufacture of bituminous felts influence their durability. Preference should be given to the different bases in the following order of priority: ~~asbestos based~~ – hessian based – fibre-felt based. **Amdt 3**

The jointing compound used for sealing the layers of felt should be:

a) a hot jointing compound that complies with the requirements of SANS 317; or

b) a cold adhesive in the form of either a cut-back bitumen emulsion, or a rubberized cement that contains a solvent.

The use of a hot jointing compound is preferred.

5.6.2 Bituminous felt waterproofing to basement floors

When a bituminous felt membrane is being applied, the following points should be observed:

a) The concrete base on which the felt is to be laid should be dry, clean, level, and free from projections. The portion of the base to which the adhesive is to be applied should be given a coat of bituminous primer and allowed to dry.

b) The felt is then cut into lengths not exceeding 7 m. These should be laid out flat in the open to allow the felt to expand before laying. No scrap lengths (under 3 m) should be used. Where end joints are unavoidable, an overlap of felt of at least 150 mm should be made and sealed.

c) Strips should be laid in accordance with the shingle method or the layer method. The felt strips are left until the wall membrane is applied and are then joined.

   Accuracy in lapping can be obtained by marking each strip along the lap line as a guide for the next strip to be laid.

   The felt should only be stuck to the concrete base around the periphery of the basement, over a width of not more 300 mm. This will ensure that any cracks that might develop in the base are not transmitted through the layers of felt. Subsequent layers are then bonded to one another over the entire contact surface, including the overlaps. Either a hot or a cold application adhesive may be used, but the hot application is preferred.

d) If a cold adhesive compound is used, the felt should be rolled with a roller of approximately 50 kg immediately after being laid, in order to expel any air that is trapped in the joints and to ensure good overall adhesion. After the rolling, a sealing coat may be applied.

5.6.3 Bituminous felt waterproofing to basement walls

When bituminous felt waterproofing is applied, the following points should be observed:

a) Mortar angle fillets should be formed at all internal corners between the floor and the wall. The wall surface and angle fillets should be dry, clean and free from any protrusions or deep indentations. If the wall is of masonry, the joints should be flushed up and where the surface of the wall is rough and uneven, a render coat of sand/cement bagging should be applied. The portions of the walls to which adhesive is to be applied should be given a coat of bituminous primer and allowed to dry.

b) The procedure in lapping and applying felt is the same as that described for the floor, except that the vertical strips should be attached by adhesive to the top and bottom of the wall, and also at vertical intervals of approximately 1 m in between, the width of adhesion in each case being 150 mm. Care should be taken that any entrapped air is eliminated by rolling along the joints. Floor and wall felt should be bonded together with the hot application of bitumen compound (see figures 1, 2 and 3).

   When a cold adhesive is used, the felt at the top of the wall will need support until adhesion to the wall has been effected. The top course of felt should be taken over the top of the wall and weighted down. It is not advisable to support the felt by nailing it to the fixing ground, or by plugs let into the wall, since these provide points of moisture intrusion and the felt might tear under its own load.

5.7 Waterproof concrete and waterproof plasters

5.7.1 Degree of watertightness

It is important that the desired degree of watertightness be established during the planning stage. Factors that should be considered include

a) the consequences of any leakage or condensation of moisture,

b) the feasibility and nature of remedial work,

c) the scope for testing during construction (for example, the controlled application of a head of water),

d) the risk of aggressive ground water penetrating watertight construction and causing damage,

e) the risk of changes to the surrounding ground water regime,

f) the need or ability (or both) to incorporate movement joints within the structure,

g) the need or ability to provide heating or ventilation (or both), and the consequences arising in terms of humidity,

h) the need or ability to provide particular floor or wall surface treatments in response either to the user's wishes or to meet some risk perceived by the designer (for example, (a) or (g) above),

i) the impact of the chosen method of construction and the risk attendant upon less-than-adequate workmanship, and

j) the balancing of cost against risk, when deciding whether increased construction cost or future maintenance cost will assume priority, or when deciding whether the building contract will place greater or less emphasis on a performance requirement.

5.7.2 Structural design

When a totally dry environment is required, the structural design of concrete basements should be determined in accordance with BS EN 1992-3.. In all other cases, structural design should be in accordance with SANS 10100-1. **Amdt 1; amdt 3**

5.7.3 Concrete

5.7.3.1 General

(See SANS 10100-2 and SANS 1200 GE for general guidance on the materials and execution of work related to the structural use of concrete.) **Amdt 1**

Fundamentally, the following points are important:

a) the use of concrete constituents (cement, aggregates, admixtures and water) that comply with standard specifications;

b) proper concrete mix design to determine the most economical and practical combination of available materials and to produce a concrete that will satisfy the performance requirements under the particular conditions of use (This includes consideration of concrete workability and selection of the appropriate water:cement ratio.);

c) proper procedures for batching, mixing, transporting, placing, compacting, finishing and curing concrete and control of these operations (Special care should be exercised to maintain the uniformity of concrete materials during construction.);

d) proper cover to reinforcement bars in accordance with the requirements of SANS 10100-2;

e) achievement of full compaction of the concrete and avoidance of segregation and honey-combing;

f) meticulous attention to details of construction joints and practices for forming them, including avoidance of cold joints; and

g) implementation of effective curing immediately after the concrete is placed, and continuation of the process throughout the specified curing period.

5.7.3.2 Materials

Materials for concrete should comply with SANS 10100-2. Cognizance should be taken of conditions or materials that can be potentially harmful to concrete (for example, excessive amounts of sulfate or chlorides in mix constituents; aggregates containing silica that might be susceptible to attack by alkalis, etc.) and appropriate precautions should be taken.

5.7.3.3 Mixes

To obtain concrete that is waterproof or damp-proof to a high degree, it is necessary not only that the concrete be dense, free from honeycombing and channels caused by bleeding, etc., but also that the cement paste itself be highly impermeable. To promote this condition (for example, for applications comprising archives and stores that require a totally dry environment), a maximum water:cement ratio of 0,5 should be used.

Where a totally dry environment is not essential and moisture vapour is tolerable (for example, workshops, plant rooms and retail storage areas), a maximum water:cement ratio of 0,59 is recommended.

Notwithstanding the above requirements, the maximum water:cement ratios and minimum cement contents should be compatible with the parameters stated in SANS 10100-2.

5.7.3.4 Durability

When concrete elements are subjected to potentially destructive elements (other than wind or loading), appropriate measures should be adopted.

For important works, mixes should be designed specifically for the exposure conditions expected for the project by a competent authority to suit the materials available and the circumstances under which the concrete will be placed. Not only will this procedure normally result in better and more reliable concrete, but substantial economics can thus often be achieved. **Amdt 2**

5.7.4 Placing and compaction

Placing and compaction should be carried out in accordance with SANS 10100-2.

5.7.5 Protection and curing

Beginning immediately after it has been placed, concrete should, as far as practicable, be protected from moisture loss and be maintained at a temperature suitable for continued hydration for the period necessary for hydration of the cement and hardening of the concrete, in accordance with SANS 10100-2. Effective curing of the concrete is one of the most important factors in producing low-permeability concrete, provided that the concrete has been fully compacted and is free from gross defects such as honeycombing.

5.7.6 Formwork

In waterproof basement construction, the following points are of particular importance:

a) The number of joints should be reduced to a minimum and cold joints should be avoided. To this end, lifts should be greater than usual, walls being cast to full height wherever possible, with due care being taken to prevent segregation.

b) Since timber spreaders inadvertently left in the construction might cause leakage, they should not be used. An acceptable type of spreader is a concrete or fibre-cement tubular member through which the tie members pass. The bolts can subsequently be withdrawn and the fibre tubes caulked. However, other suitable types are also available. The problem of spreaders can be avoided by the use of formwork that is externally shored. **Amdt 2**

c) Steel ties should not be used unless they are of the break-off type.

5.7.7 Joints

Construction, contraction and expansion joints are potential sources of leakage. Efforts should therefore be made to reduce their number to a minimum, and to plan the position and treatment of each joint beforehand.

All joints should preferably include a plastics or rubber waterstop in their construction. For the effective use of a waterstop, however, a minimum thickness of concrete of approximately 225 mm is recommended (see figure 11).

The efficacy of the bonding of fresh to older concrete is very important in producing waterproof concrete, and the methods described in SANS 10100-2 should be used.

It is recommended that adjacent sections of concrete be placed before chipping of the old concrete becomes necessary.

When waterstops in joints are being used, care should be exercised not to damage the material when the old concrete is being treated. While the new concrete is being placed, and during compaction, particular care should be taken to ensure that no air is entrapped in the joint.

When lengths of waterstops are to be joined by a simple butt joint, the jointing may be done on site in accordance with the manufacturer's instructions, but where more complicated joints are required, such as three-way or four-way pieces at junctions, the joints are best fabricated by the manufacturer.

5.7.8 Waterproof coatings, plasters and toppings

Surface coatings that consist of certain proprietary products, and plasters and toppings that incorporate certain admixtures have been reported to be effective against positive heads of water when applied to quite ordinary concrete. However, it is suggested that concrete be waterproofed rather by using the methods mentioned in this subclause, and that coatings, waterproof plasters and toppings be relied upon only to combat dampness.

5.7.9 Quality control

The quality of the concrete should be controlled in accordance with SANS 10100-2.

5.8 Cavity construction combined with drainage or pumping (or both)

5.8.1 General

A form of construction that is much used in this country is a basement that has cavity walls and a floor with drainage leading to a sump from which any accumulated water can be pumped away (see figures 12, 13 and 14).

5.8.2 Applications

When a cavity construction such as shown in figure 12 is to be built, care should be taken that the wall cavity is completely free from mortar droppings or rubble (or both).

Figure 12 shows a cavity construction used together with a waterproof membrane. This method probably errs on the conservative side, since it uses all three methods of protection, i.e. a waterproof membrane, the concrete itself, and a cavity with a subfloor drainage and pumping system.

6 The waterproofing or damp-proofing of floor constructions

6.1 Floors in contact with the ground

6.1.1 Scope

This subclause is concerned with solid floors in contact with the ground. It only deals with those cases where the moisture in the ground below the floor is that absorbed from the surrounding ground and rising by capillary action to the underside of the solid floor slab (see SANS 10109-1).

6.1.2 Concrete surface beds

Moisture rises through capillaries formed by the fine soil particles and will collect on the underside of any barrier placed on the surface of the ground. If a concrete surface bed is laid direct on compacted soil, moisture will gather on the underside of the slab and migrate to the surface, possibly causing damage to certain floor finishes and commodities stored directly on the surface bed. A layer of hardcore on its own (if used) does not prevent damp or water vapour from entering the slab. It is therefore good practice to lay down a waterproof membrane to prevent moisture penetration and so protect floor finishings and coverings.

In many areas, the ground water might have a high pH value (i.e., be alkaline) or a low pH value (i.e., be acidic). Aggressive ground water might attack the underside of the concrete surface bed and foundations to cause chemical reactions and loss of strength. It is advisable to check soil conditions and design concrete mixes accordingly. Information on the mechanisms of corrosive attack of concrete by water, on sampling of water for analytical purposes, on tests that should be carried out to determine aggressiveness, and on recommendations for anti-corrosive counter-measures, is given by BRE Special Digest 1 in *Concrete in aggressive ground – Part 1: Assessing the aggressive chemical environment*. **Amdt 2**

Ground water or hardcore materials that contain sulfates can be responsible for chemical attack on concrete floors. Where moisture is able to move through filling beneath the concrete by capillarity, or as a result of a high water table, any soluble salts present can be extracted and concentrated in pockets beneath the floor slab or transferred into the concrete as the moisture moves up through it to evaporate from its surface. The combination of sulfates with calcium sulfo-aluminate present in portland cement forms calcium sulfi-aluminate which can result in disintegration or expansion (or both) of the concrete. The effects of the expansion can either be a lateral movement, which will tend to move the foundation walls outward, or, in instances where such lateral movement is sufficiently restrained, a movement causing "bowing" or "bridging" of the slab. The concrete should be cured to prevent loss of water from the top surface. It is therefore prudent to install a membrane below the slab and foundations to assist in retaining the water and to reduce cracking due to initial moisture shrinkage, but this could aggravate the upward curling of the slab.

No site will be completely dry. As mentioned before, moisture rises by capillary action, and even “dry sites” can contain surprisingly high amounts of water. Also, water tables vary, and a site that is normally considered a “dry site” might rapidly change its characteristics and present serious problems with damp.

It is advisable, particularly on sites that are sloped or low-lying and permanently damp or liable to flooding (or both), to restrict the amount of water that can reach the foundation areas of the building, by the use of land drains and French drains or cut-off trenches, and by the provision of adequate surface water reticulation drainage.

Where the ground water level is normally high, or can on occasion be high as a result of fluctuations in the levels of local rivers, or where surface water is slow to drain away, such as on sites of impervious clay, except where an effective tanking membrane is provided, the horizontal waterproof membrane should be placed above the maximum level to which the water is likely to rise.

6.1.3 Variation in floor coverings

Since different floor coverings and the adhesive materials used in bonding them to the screed vary in their susceptibility to damage by moisture, the nature of the floor covering should be taken into account when the minimum standard of floor construction required in any particular circumstances is being selected. **Amdt 2**

6.1.4 Floor slab construction

The floor slab shall be designed and constructed in accordance with the provisions of SANS 10109-1 and SANS 10109-2. **Amdt 2**

Capillary action can be reduced by the provision of a layer of sufficiently coarse, hard, non-absorptive granular material of thickness 100 mm between the compacted soil and the surface bed of concrete.

Table 1 Deleted by amendment No. 2

6.1.5 Polyolefin damp-proof membranes for surface beds

6.1.5.1 General

Polyolefin damp-proof membrane sheeting can be used in any one or more of the following:

a) between the slab and screed to become a floating screed as defined in topping applications in SANS10109-2; **Amdt 2**

b) under the surface bed on top of the compacted subsoil; and

c) under the surface bed on top of a layer of sand blinding.

In the case of very wet sites with a possibility of loss of fines from the concrete slab and foundations, the sheeting can be used to fully wrap the substructural construction, to provide full waterproofing and a stable condition for the curing of the concrete.

6.1.5.2 Dry sites

In the case of "dry" sites the minimum construction is concrete of thickness 75 mm laid on one layer of polyolefin waterproof sheeting of thickness 250 µm that complies with the requirements of type C of SANS 952. The minimum site preparation required is good consolidation and a level filling material that is free from sharp objects that could tear or puncture the sheet.

The sheeting should be laid with the minimum number of joints and should be turned up, dressed to the wall faces and lapped with and bonded to the horizontal damp-proof course in the wall.

The minimum lap should be 150 mm and the lapping and bonding of the waterproof sheets to each other and to the damp-proof course should be carried out using a compatible solvent welding adhesive strictly in accordance with the manufacturer's specifications (see figure 15(a)).

6.1.5.3 Wet sites

Where adverse wet site conditions or aggressive waters (or both) exist, it is recommended that the specification be upgraded to use one layer of 750 µm thick waterproof sheeting that complies with the requirements for type A of SANS 952.

The sheeting should be laid with the minimum number of joints that are welded or made in accordance with the manufacturer's instructions, and should be turned down into the excavations under and around footings and returned up in the wall to be lapped and bonded with the horizontal damp-proof course in the wall (see figure 15(b)).

The specification for site preparation should require the fill to be well compacted and, if necessary, to receive a sand blinding of not less than 20 mm. This blinding layer should be introduced into the trench bottoms that have been well rammed and the waterproof sheeting should be laid and dressed into the footing trenches and up the sides of the excavations. The concrete for the footings should be placed carefully to ensure that the membrane does not sag or tear. When the footings

have cured sufficiently to allow subwalls to be erected, the latter should be brought up to ground level. The waterproof sheeting should be lapped and bonded to the vertical membrane rising behind a protective brick skin to at least 2 courses above the finished ground level. On the inner side of the subwall, the sheeting should be brought to the face of the wall to bond with the horizontal membrane under the slab. Before backfilling is commenced, the sides of the subwalls should be slushed with a weak mortar mix and the membranes brought up against the face of the subwall or, in the case of the exposed face, behind the protective brick skin.

6.1.6 Bituminous felt waterproof membranes for surface beds

The minimum construction recommended when bituminous felt is used as a damp-proof membrane on a “dry” site, is a single layer of bituminous felt complying with the requirements for type 40 of SANS 92, laid on a well-compacted fill that is free from any objects that could damage the waterproofing. The membrane should be inorganically based and should be lapped and welted to the horizontal damp-proof course in the wall. The bituminous felt membrane should preferably be positioned between the oversite slab and a screed or structural slab.

For “wet” site construction, the specification should be upgraded to two or more layers of waterproofing.

All jointing, lapping and sealing of layers upon one another should be carried out using a hot bituminous compound, and all laps, joints and bonded areas should be well rolled to ensure that there is no entrapped air.

6.1.7 Mastic asphalt finishes **Amdt 2**

This type of finish is durable and non-dusting, offers good resistance to moisture penetration, and matures rapidly after laying. The designer in consultation with the asphalt contractor should fix the hardness of the finish required to suit the service conditions concerned. (Special asphaltic compounds, which offer resistance to certain acids and to milk products, are available, but as they are proprietary types they are not covered by this standard.) The provisions of an underlay for this finish is recommended, as it retards the cooling of the mix when spread on the base and isolates it from any foreign matter (for example, oils, chemicals) that the base might contain. **Amdt 2**

6.1.8 Bitumen emulsion — Cement finishes **Amdt 2**

This type of finish is essentially a mixture of bituminous emulsion, various additives, cement, and graded fillers. The finish is durable and non-dusting, matures rapidly after laying, and is usually black in colour. It is not recommended for use in locations where it will be exposed to temperatures below 1 °C. **Amdt 2**

6.2 Floor constructions exposed to surface water or flooding

6.2.1 General

This subclause covers external floors such as on verandas, or internal floors such as in bathrooms or kitchens.

Standing surface water or water lying on the floor as a result of flooding should be drained away as quickly as possible to reduce its effect on the slab or sub-base (or both).

Standing water, unless adequately resisted by the floor finish, will penetrate the subfloor and could result in expansion or shrinkage owing to moisture movement of the floor finishes and of the slab or sub-base.

If a water-based adhesive is used in tile or in sheet flooring, detachment of the finish will occur. Where spirit-based adhesives are used, deterioration of the adhesive could occur owing to water penetration, with consequent failure of the flooring.

Where floors are superimposed direct on a membrane of bituminous felt, solution or emulsion, or mastic flooring, the treatment will vary according to the type of floor finish chosen and the nature of the traffic for which the floor is designed. On surface beds with concrete toppings (thickness 20 mm), the total thickness (surface bed and concrete topping) should be at least 95 mm.

(See also SANS 10109-2.)

NOTE Balcony construction is dealt with under the clause devoted to flat-roof construction.

6.2.2 Internal floor construction where water may stand

The degree of resistance to water penetration required where water is likely to stand varies with the amount of water likely to be encountered, i.e. to the intended use of the area under consideration.

The minimum requirements for such conditions are impervious surfaces and joints with floor finishes laid to fall to floor channels or floor outlets (or both) to remove all surface water.

Where regular surface water flooding is likely to be encountered and the underside of the concrete slab forms the ceiling to rooms below, it is essential that a waterproof membrane be provided above the slab.

7 Damp-proof courses to suspended timber floors at ground level

7.1 Control of moisture content and movement

Because of the relatively high rates of drying shrinkage and moisture movement associated with timber, shrinkage and expansion of all types of wood flooring can cause problems. The moisture content and dimensions of timber sections can alter appreciably with changes in the environment in which they are positioned. Shrinkage of joists can be responsible for movement and cracking of partition walls.

7.2 Ventilation and prevention of rot

To minimize the risk of rot in a suspended timber ground floor construction, precautions should be taken to avoid dampness accumulating beneath it. The ground below should be covered with a 75 mm thick concrete slab. Where there is a risk of flooding, the level of the slab should be above the external finished ground level.

Sloping sites can be prone to occasional flooding, and this should be kept in mind at the initial design stage.

The floor joists should be at least 450 mm above the surface level of the oversite concrete. Ventilation of ground floor timber joists, wall plates and boarding should be provided by incorporating suitable air bricks in the external walls and constructing the sleeper walls in honeycombed brickwork (see figure 16). It is recommended that all subfloor brickwork be of engineering units with a compressive strength of not less than 25 MPa. The total water-soluble salt content should not exceed 0,5 % by mass and the water absorption should not exceed 7 % (see SANS 227 for test methods). The air bricks should be situated at least 150 mm above the finished ground level to avoid the ingress of water splashing up from the ground, and should be provided as set out in SANS 10082.

Care should be taken not to restrict free air movement through air bricks by having raised gardens or paths adjacent to them or building extensions or outbuildings in close proximity to them.

Where a suspended timber floor is built below ground level, it should be provided with ventilation by means of impervious vertical ducts that are taken to outlets or ventilation grilles at least two brick courses above the finished ground level.

7.3 Damp-proof courses

7.3.1 General

Damp-proof courses (DPCs) should be provided either in the walls or immediately below the wall plates that carry the supporting floor joists.

It is good practice to bed down wall plates on a mortar bed above the DPC, taking care that no capillary path for moisture by mortar bridging of the DPC occurs.

The ends of the ground floor joists should not be in contact with the external walls. (The joists of intermediate timber floors should not project beyond the inner leaf of cavity brickwork.)

It is advisable that the timber specified for all wall plates and joists receive pressure impregnation preservative treatment.

7.3.2 Suitable types of material

A variety of materials can be used for a DPC:

a) one layer of 0,325 mm polyolefin damp-proof course, that complies with the requirements of SANS 952 (type B) and is laid in type A mortar (SANS 10249);

b) one layer of bituminous felt (inorganically based), that complies with the requirements of SANS 248 and is laid in type A mortar (SANS 10249), or one layer of bituminous sheeting;

c) copper sheeting of minimum thickness 0,25 mm and that complies with the requirements of EN 1172 (not commonly used in South Africa). (Copper sheeting resists corrosion from mortars and concrete. It can easily be bent at changes of level and it adjusts itself to any unevenness of the bed without fracturing or extruding); **Amdt 1**

d) mastic asphalt, that complies with SANS 298, is used to tank the subfloor of the inside face of the external wall up to and coincides with the DPC in the external wall (not commonly used in South Africa);

e) LLDPE (linear low density polyethylene) or VLDPE (very low density polyethylene), all in accordance with the manufacturer's specifications;

f) slates: at least two layers of highly impervious slates set in mortar should be used and the butt joints in the layers should be staggered. The slates should be of thickness not less than 6 mm. Slates obtained in South Africa usually have a water absorption of between 0,4 % and 1,2 %, as determined in accordance with SANS 227, but slates are not commonly used in South Africa; or

g) lead sheet of mass at least 20 kg/m^2, that complies with the requirements of EN 12588 (not commonly used in South Africa). **Amdt 1**

NOTE Lead is affected by contact with lime or cement mortar in the presence of moisture. It is therefore recommended that it be protected on both sides with a bitumen-based material or coated in hot bitumen or bitumen emulsion.

7.4 Damp-proof membrane

7.4.1 General

If additional protection for a suspended timber floor construction is required, a damp-proof membrane should be installed below the ground slab on top of the consolidated fill. The slab could be designed to carry sleeper walls or piers, if necessary.

The suitable materials are the same as those described in clause 6 for the waterproof membranes in solid ground floor slabs.

7.5 Details of damp-proofing of suspended timber floors

Many satisfactory details of good building practice exist for the damp-proofing of suspended timber floors. **Amdt 2**

In South Africa, with its ubiquitous termites problem, it is probably better to provide suspended timber floors on a concrete surface bed complete with a damp-proof membrane (DPM) and a consolidated fill that is treated for termites. The floor boards can then be supported by battens fixed to the concrete surface bed at the usual centres calculated at 20 times the thickness of the floor boards (see figures 16~~(a) and 16(b)~~). **Amdt 3**

As long as the space between the floor boards and the concrete is adequately ventilated, this method is well in keeping with current building practice.

8 External walls above ground level

8.1 External masonry walls

8.1.1 Introduction

Rainwater striking a wall surface can penetrate the wall by any of the following means:

a) penetration through cracks in the masonry units, cracks in the body of the mortar joints or separation cracks;

b) penetration through the body of the masonry units or the mortar; and

c) penetration through perpendicular joints that have not been properly filled with mortar.

It should be stressed that transmission of moisture through openings in the mortar owing to bad workmanship and through separation cracks is almost invariably much greater than transmission by permeation through the units. The formation of separation cracks can be minimized, and often virtually eliminated, by the use of masonry units that have a minimum rate of absorption, by wetting units with higher initial rates of absorption on the day before laying, by attention to the mortar mix and by ensuring the best contact possible between the units and the mortar joints.

The finishing-off of the mortar joints between the face bricks plays an important role and can take on various forms as illustrated in figure 19. Attention is usually only paid to the aesthetic value of the joints and the functional role is neglected. The half round joint performs the best against water penetration. If the raked recess joint, which is sometimes considered more attractive than the half round joint, is used, then not more than 8 mm mortar should be scraped out. The joint must then be pointed very thoroughly in order to prevent water penetration. The flush, half round and recessed joints are the most commonly used in South Africa.

Clay masonry units with a high initial rate of absorption will require wetting to reduce absorption of water from the mortar, in order to ensure that sufficient water remains in the mortar for proper hydration of the cement. Information on materials and specifications for the use of masonry units is given in SANS 10249, The Clay Brick Association's *Technical guides*, and in *Masonry manual* and *Detailing of concrete masonry*, both by the Concrete Manufacturers Association (CMA). **Amdt 2**

8.1.2 Natural stones

There are many varieties with differing characteristics and chemical compositions. In all cases, careful selection and detailing will reduce the effect of moisture penetration and ensure a longer life from these expensive building units.

Limestones are often affected by atmospheric pollution, and surface erosion owing to sulfur dioxide in the atmosphere is a common defect. Correct and careful design detailing of sills, projections and bases can, however, reduce the effects of damage by water and by air-borne chemicals.

Sandstone can be affected by the migration of cementitious mortar to the surface of the stone as a result of the mortar's being leached out by rainwater. The surface of the stone hardens, the stone behind weakens and eventually the hardened surface flakes off.

Sandstone can be damaged by the reaction of sulfur dioxide on limestone to form calcium sulfate. If placed in close proximity to limestone, the sandstone will be damaged by the water-borne migration of the calcium sulfate from the limestone to its surface. It is therefore prudent not to place limestone and sandstone in close proximity to each other.

Some natural stones tend to delaminate, usually in the direction of their bedding planes. It is therefore advisable to lay stones on their natural bed face.

Care should be taken to ensure the correct placing and sufficient provision of damp-proof courses and flashings. The latter need to be carefully chosen with regard to chemical actions and staining. Bad positioning or inadequacy of damp-proof courses and flashings often causes damp to penetrate through the walls and the stone to decay.

8.1.3 No-fines concrete

The use of this material has certain inherent advantages. No-fines concrete is a concrete composed of cement and a coarse (single-sized) aggregate only. Its drying shrinkage is low, and the capillary absorption of water is virtually eliminated. No-fines concrete walls should be plastered. Figure 18 shows a typical section of external wall.

8.1.4 Mortar mixes

SANS 10249 gives details regarding mortar types and mortar mixes. Only mortar classes I and II should be considered. Refer to SANS 50413-1 for specifications of masonry cement.

8.1.5 Waterproofing at window and door openings

8.1.5.1 General

There are several methods for installing windows and external doors in solid masonry walls. Figures 21 to 30 illustrate only a few of the possible correct applications of the general principles that should be followed for the laying of DPCs. These principles should be followed to provide trouble-free construction.

Although it has been common practice in many parts of the country to omit DPCs, this is considered to be imprudent.

8.1.5.2 Sealing compounds for joints

Various types of sealing compounds for joints are available at present and are being increasingly used to seal peripheral and other types of joints that occur in the fitting of window frames and curtain walling sections to openings in wall faces. Such compounds are expensive and their use can

often be avoided by good detailing. Mortar has been, and still is, commonly used for peripheral joints in these situations, especially in domestic construction and in internal joints.

The joint sealing compound chosen for such work should be of such a composition that it will not stain the surrounding structure, will receive paint without "bleeding", will not sag or run, and will not set hard or dry out under normal weather or temperature conditions. Such compounds should, however, only be used to seal joints in conjunction with DPCs and waterstop, and should not be expected to provide the only form of water resistance. **Amdt 1; amdt 2**

8.1.5.3 Waterbars, weather mouldings, sills and head frame drips

The thresholds of external doors or window sills should be provided with waterbars. These normally consist of a brass strip (or any other suitable non-ferrous metal) of thickness approximately 4 mm to 6 mm, set into the subsill of precast concrete, slate or other hard natural stone such as granite, in a lead caulking (see figures 21 and 30).

A timber (normally hardwood) sill is set over the bar and (in the case of a window sill) set in a non-hardening caulking or sealing compound. In the case of a door sill, the bottom member is rebated over the waterbar and a weather mould is set into the bottom of the door. These should be used in conjunction with a DPC to provide a high degree of waterproofing and rain resistance to the sill threshold.

Subsills and thresholds should be fabricated of dense vibrated concrete, slate or other natural stone. (Sedimentary types such as limestone or sandstone are prone to staining or spalling in these positions.)

They should be profiled to have a fall of at least 3º on the underside, cut with a drip groove, the back edge of which should be at least 15 mm from the finished wall face when positioned. It is preferable to provide side stoolings to the sill that are formed or tooled to throw surface water back from the sides of the sill to discharge over its leading edge. This is done to obviate unsightly pattern staining of the wall, formed by water dripping off the edges of the sill where they are built into the wall.

Sill members (preferably hardwood) to wooden window frames should be provided with drip grooves on the undersides.

The heads of wooden frames should have weather moulds or drip grooves provided on their undersides.

Steel-framed windows should incorporate weather drips at their heads, to get rid of any water from the junction of the opening casement and the main frame section.

8.1.5.4 DPCs in openings in solid masonry walls

8.1.5.4.1 Door thresholds (see figure 21)

The damp-proof course, where necessary, should be bedded in cement-sand mortar on a course of bricks not less than 150 mm above ground level. The subsill should then be bedded in cement-sand mortar on top of the DPC. (Care should be taken to lap and bond the horizontal DPM that protects the ground floor slab and the DPC before bedding down on the brickwork.)

8.1.5.4.2 Window sills (see figures 23 to 30)

In the case of concrete, slate or stone subsills, the DPC should be laid into the prepared wall and dressed over the face of the wall to project beyond the face of the wall or any applied finish. Where there is a timber ground set into mortar or cut brick bedded in mortar to support a timber internal sill,

the back edge of the DPC can be tacked to this with felting tacks. Where the internal sill is to be of tile, slate, stone or precast concrete (terrazzo), the DPC can be returned over the top of the inside of the wall to be bedded on mortar and later held in place by the sill bedded in mortar. The DPC should extend 115 mm beyond the opening into the wall on each side. Where the window is a steel frame section, the DPC can be under the sill and fixed with bitumen or compatible adhesive to the underside of the sill section of the fixed frame. The DPC should be extended over the opening on each side.

In the case of an aluminium frame, a hardwood subframe is fixed before the fixing of the aluminium frame (to protect the aluminium from the effects of alkalis in cement mortars.) The detail then corresponds to that for wooden window frame sills, as described below.

Where wooden window frames have sills applied direct to external wall openings without a subsill, the DPC of necessity has to be positioned one course below the internal sill, and one course is bedded over the DPC in 1:3 cement-sand mortar. The DPC should extend 115 mm over the opening on each side.

8.1.5.4.3 Window and door heads

For window and door heads, damp-proofing is handled as follows:

a) where timber window or door frames are installed, the DPC should be stepped from the inside to the outside; and

b) where the window or door frame is a steel section, the DPC should be dressed down from the inside to the outside (see figures 23 and 27).

Aluminium frames are fixed to hardwood subframes and the details are similar to those for timber windows.

8.1.5.4.4 Reveals to openings

Here, DPCs are handled as follows:

a) where timber window or door frames are installed, they should be so positioned that a horizontal and vertical DPC can be built in as shown in figure 27;

b) where a steel frame window or door is installed, a horizontal and vertical DPC should be built in as shown in figures 23 to 27.

Aluminium sections are fitted into hardwood subframes.

Acceptable alternative details of steel window frames in no-fines concrete walls are shown in figures 25 and 26.

8.1.5.5 Waterproofing of parapets (including copings) in solid masonry construction

A DPC should be positioned directly under the coping, whether it be of precast concrete, slate, stone or brickwork. Copings of precast concrete, slate or stone should have a profiled top surface either in one direction, with a fall towards the roof, or in both directions. The undersides of the projecting edges should have drip grooves. The lengths of copings should be as long as practically possible, in order to reduce the number of vulnerable exposed joints. Allowance should be made for the necessary expansion joints in the coping, which should be filled with proprietary non-hardening sealant designed to withstand ultra-violet radiation and heat absorption without becoming brittle.

A damp-proof course should be provided at a height of not less than 150 mm above the abutment of the roof. It should form a moisture-proof unit with the roof slab waterproofing (see figure 33).

Figure 35 shows various correct and incorrect methods, as follows: **Amdt 2**

a) correct detailing, showing a DPC under the coping, the mastic asphalt roof finish dressed up over an angle fillet at the junction of the roof slab and parapet and a cover flashing linking the DPC and roof finish;

b) rainwater penetration into the structure as a result of the omission of the DPC under the coping, omission of drip grooves on the underside of the coping and failure of the roof finish owing to omission of an angle fillet;

c) rainwater penetration into the parapet through the coping (especially the joints) owing to omission of a DPC;

d) correct detailing, showing cement-sand render to both faces of the wall, a DPC beneath the coping and four brick courses above the roof, throatings on the underside of the coping on both sides, correctly detailed roof finish with angle fillet, protective stone and cover flashing, and an air space between the edge of the roof slab with a slip joint between the soffit of a concrete slab and the brickwork; and

e) rainwater penetration to the internal wall and ceiling area caused by deeply recessed jointing of the brickwork and incorrect detailing of the roof finish.

Condensation problems might also be encountered as a result of cold bridging.

Copings should be bedded in 1:4 cement-sand mortar, with pointed joints and the necessary expansion joints as previously mentioned.

The parapet, in contrast to the structure below, is exposed to the weather on all sides. This can cause a difference in appearance and accentuate the tendency to relative movement between the parapet and the structure below. Such possible dissimilarity in appearance can be avoided by the use of a cavity construction for the parapet or, in the case of solid parapet walls not rendered on the outside, by the application of a cement rendering or two coats of bituminous material to the inside face of the parapet.

The relative movement between the parapet and the structure below is caused by temperature differences and changes in moisture content. This is accentuated in cases where the reinforced concrete framework of the building is not carried up into the parapet since the framework has a restraining effect.

Solutions to the problem should aim at restricting the relative movement. Expansion joints, at intervals of not more than 15 m, should be provided to permit differential movement between the parapet and the structure below. Control joints in parapets can be anything up to twice the frequency of those in the building below.

8.1.6 Damp-proof courses

A DPC is a barrier that is laid to prevent the passage of moisture or water vapour from one part of the building to the other (see figures 27 to 35).

A DPC should be impervious to moisture and immune to weathering and attack by vermin, mould, bacteria and termites. The DPC should be sandwiched in wet mortar. It should have an effective life equal to that of the structure or the part of the structure in which it is used. The use of a DPC should have no adverse effect on the stability or durability of the building.

In some parts of this subclause, the constructions are stated to be suitable for "severe climates" or "exposed conditions". In 8.8.2, reference is made to conditions in coastal areas such as Cape Town or Durban. Similarly, "moderate exposure" is equivalent to the conditions prevailing in the Gauteng area.

Information regarding the performance of the various materials used as damp-proof courses is given in SANS 10249.

8.1.7 Flashings to external walls

8.1.7.1 General

Flashings should be impervious to water, should not be subject to corrosion in their intended position, and should have sufficient stiffness to resist movement in the flashing which could be detrimental. In addition, the flashing should retain these qualities under the conditions of exposure to which it will be subjected.

Where a flashing has to be fixed into a raked-out joint and cement mortar is to be used for pointing, the mortar should only be slightly damp and should be tamped firmly into place with a blunt-nosed tool.

Plastics or mortars of any mix pressed into place with a trowel are unsatisfactory as regards holding power and waterproofness. As an alternative to mortar, a joint-sealing compound may be used.

8.1.7.2 Materials

This subclause details materials and their common application to different parts of a building.

Flashings are usually of metal and are made of lead, copper, zinc, aluminium or galvanized steel (usually referred to as galvanized iron). It should be noted that galvanized steel flashings might have a limited life, especially in a marine atmosphere. Because of the possibility of galvanic corrosion, care should be taken when using dissimilar metals in close proximity to one another. Table 2 lists the recommended thicknesses for metal flashings, and also refers to an appropriate specification, compliance with which will ensure a satisfactory product. Lead and aluminium might corrode when tucked into cement or lime mortar brickwork, and under this condition of use, should be given a protective coating of bituminous compound.

Other materials used as flashings include fibre-cement, mastic asphalt and bitumen-based sheeting materials. Mastic asphalt that complies with SANS 297, or bituminous felt type 60 of SANS 92, will be suitable.

8.1.7.3 Types of flashing to joints

Where relative movement could occur between adjacent surfaces situated in different planes, the joint between the two surfaces is usually rendered waterproof with a cover-and-apron flashing, as illustrated in figures 33, 34 and 36.

As the coefficients of thermal expansion in most flashings are moderate to high, expansion joints should be carefully considered and fabricated.

Flashings are mainly used in roofing. A direct waterproofing joint between the roof cover and abutting features, such as chimney stacks, vent pipes, parapets, etc., cannot be made without a flashing (see figure 38).

Table 2 — Materials used for flashings

1	2	3
Material	**Conforming to specification**	**Recommended thickness of material** mm
Lead[1)]	EN 12588	1,80 – 2,50
Copper[1)]	EN 1172; should be hot-rolled in dead soft temper	0,45 – 0,70 0,80 for non-industrial areas 1,60 for industrial areas
Aluminium	EN 485-1, 2, 3, 4, EN 515, EN 573-1, 2 and 3; should be of at least 99 % purity	0,56 – 0,90
Galvanized steel	SANS 3575 and SANS 4998; for galvanized class C coatings only	0,70
Non-woven fabric reinforced system	–	1,80 – 3,00
[1)] Rarely used in South Africa, except in the restoration of historic buildings.		

Amdt 1; amdt 2

8.2 Cast-in-situ concrete walls

8.2.1 Concrete walls made of normal density concrete

Reference to 8.8 indicates that a concrete wall of thickness 150 mm, externally plastered or otherwise suitably finished, will have adequate rain resistance in any part in South Africa. Walls of a lesser thickness might also be satisfactory, provided that the wall is uniformly dense and free from cracks.

For guidance on the production of dense, waterproof concrete, reference should be made to 5.7, although substantially lower cement contents and higher water-cement ratios can be used, because the conditions of service for walls above the ground are not as severe as those for walls below ground level. Structural design should be carried out in accordance with SANS 10100-1.

8.2.2 Cast-in-situ concrete external walls, made of lightweight aggregate

In the case of lightweight aggregates, the danger of shrinkage during hardening is considerably higher and more variable and moisture movement is much more marked, and it is therefore more difficult to render construction joints watertight. Construction with lightweight aggregates therefore presents the same problems as in the case of normal aggregates but in rather more acute form, and similar precautions are required.

An external rendering should always be applied when lightweight aggregate concrete is used. Lightweight aggregates from certain sources, such as industrial furnaces, require checking to establish that they do not contain unstable chemical materials.

Lightweight aggregates should conform to the requirements of SANS 794.

8.2.3 No-fines concrete walls (plastered)

8.2.3.1 Introduction

No-fines concrete is composed of coarse aggregate, cement and water only, the fine aggregate being omitted. Refer to table 3 for mix proportions. The mixture results in a concrete containing evenly dispersed, comparatively large interconnected voids. This gives it different properties from

normal concrete, an important property with respect to rain resistance being the absence of capillary passages through which moisture can be drawn deeply into the interior of the concrete. It is therefore well suited for use in external walls, provided that a plaster coat is applied to the outer face. This finishing is essential, since water can otherwise be readily poured or forced through the no-fines concrete as a result of wind pressure.

8.2.3.2 Aggregates

While a range of materials can be used in no-fines concrete, they should fulfil the following basic requirements:

a) all particles should be more or less of the same size and there should be a minimum of elongated, flat or flaky material. This will ensure that the voids are not filled with undersized material;

b) the particles should be sufficiently strong for the purpose envisaged. The aggregate should not crush under the loads that will be imposed on the concrete, nor should the particles break down during the mixing process;

c) the surface of the particles should be clean and hard, to enable cement to adhere firmly; and

d) the aggregate should be durable and stable.

It is an advantage if the aggregate has a low absorptivity. However, if a porous and absorbent aggregate is used, it should be saturated beforehand by soaking it in water and draining for about an hour before use.

The most commonly used aggregate is crushed stone.

Crushed clinker, or hard ash resulting from the burning of coal in industrial furnaces, is normally variable and unreliable, and might degrade in service; it may be used only if found acceptable by laboratory testing. Mixes rich in cement are usually necessary with clinker aggregates.

No-fines concrete has been made successfully with aggregates that range in nominal size from 6,7 mm to 75 mm, but by far the most common material is a nominal 19 mm.

As in the case of normal concrete, the minimum thickness of no-fines concrete should be not less than approximately 5 times the nominal size of the aggregate.

Mixes made with small stone (13,2 mm or 9,5 mm) are easier to place and give a finely textured surface.

8.2.3.3 Cement

Common cement type I (CEM 1) is recommended for all normal uses. Rapid-hardening portland cements are useful where high early strength or reduction in curing time is required. Common blended cements should be used with discretion since they necessitate rather longer periods of curing. **Amdt 2**

8.2.3.4 Mix proportions

For walls, recommended volumes of stone per bag (50 kg) of cement range from 300 L for a concrete requiring higher strength to 350 L where strength is less important (see table 3). **Amdt 2**

The amount of mixing water used is critical. It depends mainly upon the size, shape, surface texture and absorptivity of the aggregate. The correct amount to use is that which is just sufficient to enable the cement-water paste to coat the aggregate uniformly with a layer of paste that runs together at

the points of contact of aggregate particles. Too much water yields a paste that is too fluid and therefore tends to flow off the aggregate particles, impairing the bond in the upper portion of the work and filling the voids in the lower part. Too little water, on the other hand, results in a paste that does not coat the aggregate properly.

For given materials and proportions, the amount of water required varies very little between batches. It is therefore recommended that the exact amount of mixing water required per batch be established by trial and inspection when the work commences, and that this amount of water be added for all subsequent batches, without reliance on the judgement of the mixer operator.

Table 3 — Recommended range of mix proportions, and resulting characteristics of no-fines concrete (data from Cement and Concrete Institute tests) **Amdt 2**

1	2	3	4	5	6	7	8
19 mm nominal size stone							
Stone per 50 kg bag of cement	**Aggregate:cement ratio**		**Compressive strength** MPa		**Cement content**	**Total water**	**Mixing water**
L	**By mass**	**By volume**	**at 7 days**	**at 28 days**	bag/m^3	L/m^3	L/bag
300	8,6	9,0	3,4	4,8	3,5	68	19
350	10,0	10,5	2,7	4,1	3,0	62	21
Stone requirements = 1,05 m^3/m^3 approximately.							

8.2.3.5 Construction joints

Construction joints should be avoided, if possible, by placing all the no-fines concrete in one continuous operation. Where this is not possible, construction joints should preferably be placed vertically. On no account should construction joints be raked.

Where construction joints occur, the exposed face of the existing concrete should be thoroughly cleaned with a wire brush and sparingly coated with cement slurry applied with a brush in such a way as to coat the exposed aggregate without closing any voids. The new concrete should then be placed immediately.

Where vertical construction joints are unavoidable, they should be kept away from openings and external angles of the building.

8.2.3.6 Expansion joints

Vertical expansion joints are necessary at approximately 15 m intervals.

8.2.3.7 Depth of rain penetration and provision of DPCs

The absence of capillary paths through which moisture can penetrate a no-fines concrete wall has been demonstrated in tests that show that the depth of moisture penetration in a rendered no-fines concrete wall is the larger of 65 mm and approximately twice the size of the largest aggregate.

Any water that does penetrate the rendering and the first thickness of the no-fines wall will slowly trickle down to the bottom of the wall, unless obstructed by the construction at openings. Heads of openings should therefore be provided with a DPC to direct this moisture outwards. Weepholes or weeplines are also needed at such points and at the bottom of the wall, to permit the escape of such water to the outer face (see figures 18 and 26(a)).

8.2.3.8 DPCs at ground level

Whilst it is current practice to use a DPC at the just-above-ground position with all types of walls, tests have shown that no-fines concrete is itself a satisfactory DPC in such a position, provided that the no-fines concrete goes to at least 150 mm below the point where complete dryness is required.

8.2.3.9 Plastering

Since there is practically no interlocking of particles and no plastic period in no-fines concrete, ample time should be allowed for the cement to harden before any other work on the wall is performed. A period of 24 h is usually required before the shuttering on the wall is stripped and a period of about 3 d before any plastering is applied. The concrete should be damp-cured during the interval between the stripping of the shuttering and the application of the plaster.

Plaster should comply with the strength requirements of mortar classes I and II. Class I is used for walls exposed to severe weather conditions, whereas class II is used for all other conditions (see 8.4.4).

8.3 Soil-cement external walls

8.3.1 General

Footings and walls below the DPC level should not be constructed of soil-cement. Soil-cement external walls should be rendered in accordance with the recommendations of 8.4.

8.3.2 Desirability of soil tests

Soil-cement is most commonly used in building units (i.e. soil-cement bricks and blocks) but can also be successfully used for in-situ construction. It should be remembered that the problem of shrinkage upon hardening is more acute with in-situ construction, since full hardening shrinkage is experienced in the complete wall. A drying shrinkage limit of 0,06 % to 0,08 % is recommended for such units. In order to construct the soil-cement blocks within these limits, tests are necessary to determine the nature of the soil and the cement and the moisture content to be observed in their manufacture.

Full information on the necessary tests, and on both block and in-situ construction in general, will be found in the National Building Research Institute's report DR2.

8.4 Plastering for external walls

8.4.1 Introduction

Plastering has been shown by test (see 8.8.2~~(d~~)) and experience to be a very effective method of increasing the rain resistance of a wall. Gross cracking will, of course, detract from this increased measure of protection, and the remainder of this subclause therefore deals with the procedures to be followed to avoid cracking. **Amdt 3**

The use of plaster on a true cavity wall is not necessary from the point of view of weather resistance, but attention to the details that follow will be beneficial because the resultant rendering reduces the potential for unsightly cracking.

8.4.2 Desirable characteristics of plastering

Plaster should possess a high water retentivity, a high plasticity and a high bonding power (adhesiveness), should not significantly change in volume both during and after hardening, and should contain a minimum of water-soluble salts.

8.4.3 Materials

The common cement should comply with the requirements of SANS 50197-1 and masonry cement should comply with the requirements of SANS 50413-1. The sand should meet the requirements for exterior plaster as given in SANS 1090, be well graded and preferably have a grading towards the coarser side of the given envelope. **Amdt 1**

8.4.4 Mixes

A rendering based on a portland cement/lime blend or masonry cement will satisfy the requirements of 8.4.3 better than a straight portland cement rendering and is therefore recommended. Class II should generally be used. Class I can be used where a higher degree of waterproofing is necessary.

8.4.5 Adhesion to walls

Adhesion of the renderings to moderately strong materials such as most burnt clay, concrete or soil-cement bricks or blocks, and sand-lime bricks, will usually be satisfactory since these units have a moderate to high suction and afford a good mechanical key for the rendering.

Where the surface to be rendered (whether of masonry or in-situ concrete) is too smooth to provide an adequate mechanical key, it should be given a spatterdash coat, as follows:

A mix consisting of 1 volume of cement to 2 or 3 volumes of fairly coarse sand is made up with sufficient water to form a thick slurry. The surface to be treated should be cleaned; if absorbent, it should be dampened, but it should not be visibly wet when the spatterdash is applied. The wet mix is thrown on with the aid of a trowel or scoop to give a rough coating of thickness not exceeding 6 mm. The spatterdash should not be worked after application, but should be hard and adhering firmly when the plaster coat is applied.

The adhesion of the rendering to no-fines concrete is satisfactory in spite of the fact that little suction exists, because the mechanical key is very good. No-fines concrete should not be wetted before the application of rendering, because the rendering tends to slide owing to the absence of suction.

The rendering of a soil-cement-rammed wall is usually carried out on the roughened surface.

In the case of materials such as the denser types of clay brick or block, or dense concrete, it is recommended that a preliminary spatterdash coating be used.

In the case of materials such as lightweight or aerated concrete, or some of the softer bricks, there is no difficulty in achieving good adhesion, but it is advisable to use a class III plaster (see SANS 10249), since the plaster should not be stronger than the wall surface.

8.4.6 Application

Normally, at most two coats, an undercoat and a finishing coat, will be required. Accurately laid block-work can often be satisfactorily plastered with a single coat. Generally, both coats should consist of materials mixed in the same proportions. A rich finishing coat laid over a leaner undercoat could result in serious cracking and flaking.

The thickness of the undercoat should be between 10 mm and 15 mm. Before it has set, the surface should be combed in horizontal wavy lines that are of depth approximately 3 mm and that are 25 mm apart, to provide a key for the finishing coat.

The finishing coat should be of thickness 5 mm to 7 mm, depending on the texture desired. The surface should be wood floated, and the use of a steel trowel should be avoided as far as possible.

Rough finishes with numerous projections for exterior surfaces tend to break up the flow of water down the wall instead of allowing a concentrated flow in relatively few places. For this reason, rough finishes provide better damp-proofing than smooth finishes. They also weather more uniformly and are more free from visible defects.

Newly applied plasters should be prevented from rapid drying out by the use of water in a fine spray applied several times a day, especially during hot weather and in drying winds. The work should not be done in full sun but should be carried out on the sides of the building where there is shade, or on the leeward sides during windy periods.

Plaster should not be applied across a damp-proof membrane in a wall. Where it is required that the wall be plastered from top to bottom, a V-joint of width 10 mm to 15 mm is required at the damp-proof level, to prevent moisture bypassing the DPC (see figures 20, 31 and 33).

8.4.7 Rapid drying of plastering is harmful

If plastering is done on a hot windy day, rapid drying could cause the formation of shrinkage cracks. On such a day it is therefore even more advisable than usual to take preventive measures, for example water applied by means of a mist spray. This is very important where masonry cements are used.

8.4.8 Provision of joints

Where differential movement between dissimilar materials such as concrete and masonry is expected, a deep V, or similar type of joint, should be formed at the line of demarcation between the two materials (see figures 34 and 35 and SANS 10249).

8.5 Integral and surface waterproofing for external walls

8.5.1 Integral waterproofing

The use of waterproofing admixtures in concrete, mortar or plaster can reduce the rate of penetration of water into these materials. However, these materials should be regarded only as an additional safeguard against the ingress of moisture.

When any waterproofing admixture is being evaluated, its effects on all the properties of the concrete, mortar or rendering should be considered, since many admixtures adversely affect desirable properties. As a further consideration, the desirable effect of the admixture should be weighed against its cost as compared with that of other methods of obtaining the same result.

The effect of admixtures on properties such as 28 d compressive strength is easily determined. It should, however, be emphasized that, especially where concrete is exposed to conditions of continual dampness, this particular property is not the sole criterion. Under conditions of continuous water pressure, some admixtures leach out after a period, leaving the concrete far more permeable than a plain concrete would have been. Other admixtures produce a tendency towards unsightly efflorescence, while some render concrete, mortar and rendering particularly liable to attack by various naturally occurring chemical agents.

Commercial waterproofing admixtures generally fall into one of three available classes:

a) finely-divided material, often described as “pore fillers”;

b) insoluble soaps claimed to impart hydrophobic qualities to concrete; and

c) organic and inorganic polymers.

The initial effectiveness and the durability of the various types vary from product to product.

8.5.2 Surface waterproofing

A wide selection of proprietary products is marketed. The choice of a suitable treatment for a particular case will influence the success achieved. Publications such as the *American Concrete Institute's Manual of concrete practice* should be consulted, especially where a high-grade coating is required or where work of any magnitude or difficulty (or both) is involved. Reputable manufacturers also can usually give reliable advice on the use of their products, especially on the compatibility of successive coats. **Amdt 2**

8.5.3 Water repellents for masonry protection

The technical development of clear liquid water repellents for the protection of masonry has now reached a stage where these products possess all the necessary performance characteristics in respect of effectiveness and durability.

The architect, contractor or specifier should, however, take care in selecting the correct product for a particular application and incorporate it as part of the basic design. Water repellents are not substitutes for proper detailing and workmanship.

There are four main types of water repellents, i.e. acrylics, silicones, silanes and siloxanes.

Acrylics and silicones form a surface film, whereas silanes and siloxanes penetrate the masonry to form a water-repellent barrier after undergoing a chemical reaction in the presence of moisture.

The application of iso-octyl siloxanes is regarded as a virtually permanent water barrier. However, due regard should be given to their correct application.

Water repellents are not able to bridge cracks or to fill voids, and these should be closed with a cementitious filler. Affordable housing built with lower-grade or a more porous type of masonry unit without cavities should be treated with an appropriate coating. **Amdt 2**

8.6 Facings of burnt clay, natural or cast stone for external walls

8.6.1 General

When facings are being detailed, particularly at openings, columns and floor levels, the principles pertaining to damp-proofing enumerated in this standard should be carefully applied.

If experience in an area suggests that facings applied to a solid wall with the joints mortar-painted have insufficient rain resistance, the use of a joint-sealing compound applied as described in 8.6.4.2, or a cavity construction (or both) is recommended.

8.6.2 Burnt clay facings

With regard to rain penetration, burnt clay facings can be considered to be similar to, but not necessarily identical with, a facebrick wall, and the requirements given in 8.8.2(~~c~~) are therefore applicable. Thus a solid construction of thickness 230 mm is definitely suitable for the Bloemfontein area, is possibly suitable for the Gauteng area (more so if a protective bituminous coating is applied to the surface of the inner backing wall as illustrated in figure 25), and is not suitable for coastal areas, where cavity construction as shown in figures 28, 29, 31, 32 or 33 should be used. **Amdt 3**

8.6.3 Natural stone facing

Granite, marble and sandstone can be used as veneers (thin facings). Both granite and marble, of the usual thickness, prevent the penetration of moisture through the facing units themselves, but sandstone is porous and should therefore be treated with an application of a protective bituminous compound on the back and sides (to within 12 mm of the face) of the stones, or an application of a transparent surface waterproofing agent to the face itself (or both). The actual thickness of the material used will affect the design of the joint. SANS 10073 provides details on the application of facings to buildings. The joints are liable to separation cracking when made of mortar, but this tendency is reduced if the leaner mortar mixes recommended in table 3 are used. The lean mixes are especially suitable for pervious facings.

8.6.4 Precast concrete facing units

8.6.4.1 Moisture penetration through the facing units

General guidance on materials and the execution of work is given in 5.7.3. Imperviousness is more easily ensured by designing the units to be of simple shape and of adequate thickness, and with a minimum of exposed faces. This applies particularly where a special facing mix is used. (This mix should be applied to a thickness of not less than 12 mm.)

Where special conditions exist, such as complicated shapes, unusually severe exposure, etc., consideration should be given to the use of a suitable integral waterproofing agent in the mortar mix, or application of a suitable surface waterproofing agent (or both) as an additional precaution.

The practice of applying a protective bituminous coating to the back and edges of the unit is not normally necessary, but might be justified in similar special circumstances or where the quality of the facing units is not reliable. Such coatings do not, however, increase the durability of the units.

8.6.4.2 Moisture penetration through the joints

Moisture is more likely to penetrate the joints between the facing units than the units themselves. The likelihood of such penetration will be minimized or eliminated if correct jointing methods are used. Points to be specially noted are the following:

a) units should be mature enough at the time of laying for hardening to be virtually complete. At least four weeks of aging after manufacture is recommended (see SANS 10249);

b) suitable mortar should be used (see SANS 10249);

c) to limit shrinkage owing to drying out after laying, units should be dry when laid;

d) correct laying practice should be observed (see SANS 10249); and

e) the joint surfaces should be properly tooled (see SANS 10249 and figure 20).

8.6.5 Cavity wall construction with facings

Facings of burnt clay and of natural stone or cast stone are often used as, or applied to, the outer leaf of the cavity wall. In such cavity construction, provision should be made for draining away any moisture that might find its way into the cavity. Weep holes should be formed at intervals in the vertical joints of the facing units and continued through the backing wall (where applicable) at a level slightly above the front portion of the stepped DPC (see figures 29, 31, 32 and 33).

The masonry of the outer leaf (i.e. backing wall) of the cavity wall should be constructed with class II mortar (SANS 10249). This wall should support the facing with the minimum of movement.

8.6.6 Methods of attaching facings

Facings can be attached to the backing wall by bonding or by metal ties (or both). Where metal ties are used, it should be realized that the metal ties are liable to corrosion, since satisfactory and permanent damp-proof conditions are difficult to achieve. They should therefore be made of copper or other suitable materials. A tie that is merely coated with a corrosion-resistant material is not considered to be entirely satisfactory. Facings are not usually considered to be an effective part of the wall for load-bearing purposes, unless they are bonded in a satisfactory manner to the remainder of the wall thickness. As a rule, multi-storey walling is, however, non-load-bearing, being the infilling in the concrete framework of the building, and in these cases tied facings are acceptable. (See also SANS 10073.)

8.7 External cladding (curtain wall and panel wall types of construction)

8.7.1 Introduction

Cladding is a non-load-bearing construction that uses large prefabricated panels either to cover the frame of the building, when it is known as curtain walling, or to act as panel infilling, when it is called panel construction.

Where curtain walling is attached only to continuous horizontal members such as floor edges, the module of the walling becomes independent of the column spacing.

In panel construction, the walling units are framed by adjacent floors and columns, and the framework is therefore not covered.

8.7.2 Materials

Materials used for cladding include precast concrete (ordinary and lightweight), aluminium or aluminium alloy, glass (set in wood, metal or concrete framework), ceramic sheets, steel (including galvanized steel and enamelled metal), fibre-boarding, timber, and fibre cement.

When used as cladding, most of these materials require some thermal insulating backing.

8.7.3 Suitability of the material itself

Aluminium or aluminium alloy, glass, ceramics, steel, enamelled metal and galvanized steel are impervious to water, even under a hydrostatic head, and are suitable for use as cladding. Where aluminium is in contact with portland cement mortar or concrete, it should be protected from corrosion.

Ordinary or lightweight concrete panels will be sufficiently impermeable, provided that attention is given to the manufacturing requirements for precast concrete facings as given in 8.6.4.1.

When timber in solid or re-assembled form is being used, the climate and locality should be taken into consideration.

Fibre-cement sheeting of thickness 6 mm or more is sufficiently impermeable to be used in the cladding of buildings.

8.7.4 Moisture penetration at the joints of panels, etc.

8.7.4.1 General

The use of impervious panelling materials results in problems with the waterproofing of the joints of such panels, since rain falling in the area will flow down the wall towards the joints, none being absorbed by the material itself.

When the joints are being designed, caulking compounds should be used wherever possible, and the principles of lapping, forming of drips, etc., should be applied. Relying on caulking should, if possible, be avoided since caulking compounds deteriorate with age. When the principles enumerated in this standard are being applied, it should be remembered that on high exposed multi-storey buildings, rain can be driven upwards.

Joints that use caulking compound should be so designed that the compounds can be easily replaced, should replacement become necessary.

The cavity wall principle can be applied to this type of construction, in which case the weathertightness of joints might not be of paramount importance.

8.7.4.2 Joint construction

The same principles that apply to precast concrete facings or veneers also apply to panels of precast concrete. The recommendations in 8.6.4.2 are therefore applicable but, because the areas of the panels are usually greater than the units used as facings or veneers, proper curing before erection is even more important, as is the use of a suitable caulking compound in the joints. Large precast panels should have lapped horizontal joints and sealed vertical joints.

Glass set in a frame of wood, metal or concrete can present difficulties with glazing clearances when the areas to be glazed are large, and especially when thermal insulating backing material, which increases the temperature range that the glass is subjected to, is used.

Aluminium and aluminium alloy are versatile materials for use in curtain and panel walling, and various types of joints are therefore possible. For multi-storey buildings, enamelled metal can also be used as a curtain and panel walling material. Joints in both aluminium and enamelled metal should, therefore, be considered on their own merits.

Joints between corrugated walling sheets are made with end laps of at least 100 mm. Side laps of metal sheets should consist of at least 1,5 corrugations, while the side laps of fibre-cement sheets are normally only half a corrugation. Sealing compound between the laps in the sheets is not necessary. Further information can be found in SANS 10237.

8.8 Artificial rain test to determine rain resistance of walls

8.8.1 General

The Division of Building Technology (CSIR) has developed an artificial rain test to determine the relative rain resistance of walls or specimen wall panels. An analysis of wind records and rainfall data, combined with a knowledge of the conditions under which the moisture content of masonry walls will increase, has enabled the Division to develop a single continuous artificial test storm of standard intensity but of a duration that varies according to the area concerned. By means of this test, the Division simulates the differing rainfall intensities of South Africa. Rain penetration tests for walls should be carried out in accordance with SANS 10400. (See SANS 10160 (parts 1 to 8), for an annual rainfall chart of Southern Africa.) **Amdt 3**

8.8.2 Practical conclusions

The general conclusions that can be drawn from the results of this test and from general experience are as given in 8.8.2.1 to 8.8.2.6.

8.8.2.1 A 230 mm wall, badly constructed

An unplastered 230 mm wall that has been poorly constructed will have inadequate rain resistance.

8.8.2.2 A 230 mm wall, well constructed

When special care is taken with workmanship, filling of joints, wetting of clay bricks, etc., as recommended in earlier parts of this subclause, the rain resistance of an unplastered 230 mm wall can be increased to more than twenty times that of a wall in the construction of which these recommendations have not been followed.

8.8.2.3 Face-brick wall

A 230 mm well-constructed face-brick wall will have an adequate rain resistance in Bloemfontein and in the Gauteng area but not in coastal areas. It is often impossible to ensure good workmanship, however, and it is therefore recommended that where a face-brick wall is required, it should be constructed as a cavity wall. A large number of solid 230 mm face-brick walls are built in the Gauteng area and the majority do not give any trouble that can be attributed to rain penetration. A number do leak, however, and it is presumed that the reason for this is inferior workmanship.

Practical experience in Cape Town and Durban has confirmed that no face-brick walls should be constructed in these and similar areas unless cavity construction is used.

8.8.2.4 A 230 mm wall, externally plastered

Plastering an ordinary 230 mm wall increases its rain resistance tenfold. Limited evidence suggests that this is valid even if the plaster becomes crazed.

External walls intended to be plastered should be built from units complying with SANS 227 or SANS 1215. **Amdt 2**

For coastal areas it is advisable to assume that a 230 mm plastered wall is not suitable, although suitable surface waterproofing agents applied at approximately 4-year intervals can increase rain resistance to a satisfactory level in those areas. A lime wash that contains 10 % tallow and 10 % salt is suitable for this purpose.

8.8.2.5 Walls thinner than 230 mm

A 150 mm wall of concrete or externally plastered masonry has an adequate rain resistance in most parts of the country.

8.8.2.6 General conclusion

The general inference to be drawn from the tests is that the external surface of the wall is of primary importance as regards rain resistance, while the thickness and type of material are of secondary importance.

8.9 Decreasing the severity of rain exposure of walls in multi-storey buildings

The construction of copings, cornices and string courses is an established and useful method of keeping some rain off the face of the wall.

Cornices and string courses are omitted in modern construction and this omission, together with the increase in the height of modern buildings, results in more severe rain concentration on the walls. In tall buildings, gutters should be built at one or more intermediate floor levels to take some of the water away.

9 Roofs

9.1 Introduction

The roof is the major element used to exclude water from the building. There are many roof shapes and many suitable materials for each shape.

The shape of the roof is usually related to the shape of the area to be covered. The roof design and roof materials are determined by the designer after the following factors have been considered: aesthetics, suitability, durability, cost, maintenance, and availability of materials.

Traditional pitched roof shapes and their variations have evolved over centuries and have proved to be a reliable and cost-effective means of providing the necessary shelter. Flat roofs have certain advantages, which are mainly aesthetical, and allow more flexibility in the planning of buildings. There are various materials and methods that can be used to waterproof flat roofs where a minimum slope is required. The earlier examples of flat roofs used sheet lead or sheet copper with a variety of joint detail as the waterproofing layer, and also mastic asphalt waterproofing material as a roof covering. Lately, modern chemistry has made many liquids or pastes available which, after application, will set and adhere to a flexible and elastic waterproof membrane (see 9.3.3.4 and 9.3.3.5 for more detail).

9.2 Pitched roofs

9.2.1 General

The pitch of a roof should be such that rain water is shed as quickly as possible. The grade of watertightness is determined by the slope of the roof covering, the design, the overlap of units and, in some cases, the waterproof underlay. Special attention should be given to the fixing methods, to detail, to the design of openings and projections (pipes, chimneys, parapets, dormer windows, etc.), and to box gutters, valley gutters, gutters, downpipes and flashings.

9.2.2 Materials

A list of common roofing materials and of the advantages and disadvantages of each is given in (a) to (k) below.

a) **Metal sheeting (corrugated, box ribbed, galvanized)**: This material is tough, inexpensive, non-flammable, effective at low pitches, and lightweight and has a long life expectancy, but it corrodes and therefore needs regular painting.

b) **Fibre-cement (profiled)**: This material has good resistance to corrosion and is heavier than, but can be laid at approximately the same slopes as, corrugated iron, and in coastal areas is usually finished with an anti-fungicidal paint. It is less robust than corrugated iron and requires more care with handling and erection. It also becomes brittle with age.

c) **Tiles (clay)**: These tiles are traditional. They are lighter than concrete tiles, but are not always available and they have a limited range of patterns. They are also susceptible to hail damage.

d) **Tiles (concrete)**: These tiles are available in various patterns and colours.

e) **Tiles (coated pressed metal)**: These tiles are light and effective and are available in various colours. They are also corrosion resistant.

f) **Natural slate**: This material is traditional, heavy and robust. It can be used with curved roofs but needs good slopes to roofs and requires to be fixed with copper nails and wires, with the result that it is essential to employ specialist contractors. Alternative lighter-weight slate roofing systems using aluminium foil are also commonly used.

g) **Fibre-cement slates**: In many respects the characteristics of these slates correspond to those of ordinary slates. They are available in many colours and are less expensive than natural slates.

h) **Copper (sheet)**: This material gives a high-class durable finish requiring traditional details. It is expensive but aesthetically pleasing.

i) **Wooden shingles**: These are generally unsuitable for the South African climate. The timber, even the best quality imported red cedar, needs regular maintenance (oiling every six months). It is a light roofing material and can be used with curves but it should only be used on roofs that have good slopes.

j) **Thatch**: Thatch is traditional, a good insulator and aesthetically pleasing, but it requires protection against lightning and fire since it is combustible and more vulnerable to fire than the so-called hard roof coverings. The fire risk can be reduced by the application of a fire retardant to the thatching. Thatching is reasonably expensive to start with, it is costly to maintain and it has a life expectancy of approximately 25 years. (See SANS 10407.) **Amdt 2**

k) **Translucent sheets**: These are usually used for roof lighting and in combination with other roof materials. Various types of translucent sheet are available, but they are expensive.

9.2.3 Underlays

Roofing underlays are used to provide barriers to vapour, dust and condensation. Where tiles are laid to minimum pitches, an underlay between the rafters and battens should be used. An additional strip of underlay membrane should be laid at ridgings and valley gutters (see figure 36). Underlays are not recommended for shingled and thatched roofs.

Roof underlays usually consist of bituminous felt (in accordance with SANS 92) or polyolefin membranes (in accordance with SANS 952).

NOTE Part L of SANS 10400 gives more information regarding roof construction and minimum allowable slopes.

9.3 Flat concrete roofs

9.3.1 General

Waterproofing materials should be transported, handled and stored with care and laid strictly in accordance with the manufacturer's instructions. A clean, dry, smooth, firm and structurally adequate base with falls of at least 1 in 50 (depending on the material selected) is required, with drainage to gutters, rainwater outlets or edges of roofs, as relevant. Attention should be given to detail design of openings, projections, gutters, downpipes and finishes to adequately provide for run-off water and to minimize blockages.

Corners and edges should be coved or angle rounded.

Bases with the necessary gradient for waterproof membranes are usually formed on top of structures in low-density screeds and then finished, when necessary (see below), with a cement-mortar topping. Screeds and toppings should be of sufficient quality to provide a firm base.

The following characteristics are suggested for screeds for waterproofing purposes:

a) compressive strength: not less than 3 MPa at 28 d when tested in accordance with SANS 5863, except that five test cubes, instead of three, be taken per valid test result for every pour of 50 m^3 or less;

b) steel-trowel finish (light);

c) drying shrinkage: less than 0,2 % when tested in accordance with the conditions of test specified in SANS 5836;

d) minimum screed thickness: 40 mm; and

e) maximum moisture content[1)] after drying (preferably 28 d), before the application of the waterproofing:

   1) applications with a density of less than 500 kg/m^3, 10 %; and

   2) applications with a density exceeding 500 kg/m^3, 7 %.

To cater for drying shrinkage and to control cracking, the screed should be cast or sawn into panels not exceeding an area of 9 m^2. Joints in the roof should be continued through the screed, so that the joints in the screed coincide exactly with those in the roof. In addition, isolation joints should be formed against walls, columns and other fixed objects, and vertical butt construction joints should be formed over the centre of any main supporting beams that occur below the screed, and at points where changes in slope occur.

Screeds with a compressive strength of less than 10 MPa and certain other screeds (for example, no-fines concrete) should be covered with a sand-cement topping that has a compressive strength of not less than 10 MPa after 28 d. The minimum thickness of this topping should be 25 mm for separate bonded sand-cement screeds, and 50 mm for separate unbonded screeds. The topping should be cast or sawn into panels corresponding with those of the screed, intermediate joints being provided to limit the maximum panel size to 9 m^2 for separate bonded toppings and 4 m^2 for separate unbonded toppings (see SANS 10109-2 for details).

Since curing has a profound effect on the properties of screeds, they should be cured under plastics sheeting for a minimum period of 7 d.

Insulating materials incorporated into flat roofs should be firm enough to support the waterproofing system and foreseeable loadings. A vapour barrier should be provided below the insulation material.

An important point to note is that concrete and screeds placed on top of flat roofs should be allowed to dry out as thoroughly as possible before waterproofing is applied, otherwise difficulties with blistering of waterproofing, damages to internal finishes, etc., are likely to arise.

9.3.2 Low-density screeds

9.3.2.1 General

Low-density screeds can be produced using a variety of aggregates, for example exfoliated vermiculite, perlite, expanded polystyrene, or clinker. Low density can also be achieved by omitting all or a portion of the aggregates and introducing air or gas to form no-fines concrete or foamed cement, respectively. For lightweight materials, the strength, insulation property and thickness of light-weight materials should be determined for each specific case, having regard to the expected loads and type of traffic to which the material will be subjected.

1) To be determined gravimetrically on samples obtained by hand chiselling (preferred) or by dry sawing.

9.3.2.2 Vermiculite screeds

The components of vermiculite screeds are expanded vermiculite aggregate, portland cement and water. The ratio of cement to aggregate determines the density, strength and insulation performance of the screeds. They tend to retain moisture, which causes them to expand.

9.3.2.3 Perlite screeds

Perlite screeds consist of a mixture of expanded perlite, portland cement, water, an admixture (or admixtures), and an additive (or additives). The ratio of cement to aggregate determines the density, strength and insulation performance of the screed.

9.3.2.4 Expanded polystyrene screeds

Expanded polystyrene screeds consist of a mixture of expanded polystyrene beads coated with a bonding agent, portland cement, sand, water and an admixture (or admixtures). Attention should be given to the recommended moisture content requirement (see 9.3.1).

9.3.2.5 No-fines concrete

No-fines concrete is normally made from crushed single-sized stone, portland cement and water. The minimum thickness of no-fines concrete should be not less than approximately five times the nominal size of the aggregate.

No-fines concrete used in roof screeds should be blinded with an integral topping of thickness 25 mm and consisting of sand, portland cement and water applied to the upper surface and finished by steel trowelling. The mix proportions for this layer are 130 L of concrete sand, measured in the moist loose state, to one bag (50 kg) of portland cement.

NOTE For additional information, see the Cement and Concrete Institute's *Fulton's concrete technology*.

Amdt 2

9.3.2.6 Clinker concrete

Clinker screeds typically consist of a mixture of crushed and suitably graded clinker aggregates mixed with water and portland cement. Sand can be used to correct the deficiencies in grading. Ash from domestic furnaces is usually not suitable for use in concrete. It is important to check that the clinker complies with the requirements of SANS 794. This check should be carried out not only at the start of the proposed work but also as a routine measure at intervals thereafter. Because of the potential problems associated with unsound clinker, for example corrosion of reinforcement, conduits, etc., the use of unsound clinker in screeds as substrates for waterproofing is generally not recommended.

9.3.2.7 Foamed cement

Foamed cement is a material that has a fine homogenous cellular structure. It is generally composed of neat cement paste, cement-sand mortar, cement-sand-lime mortar, or lime mortar, aerated in such a way that the set product has 35 % to 85 % of small voids uniformly distributed throughout its mass.

Methods of manufacturing foamed cement include chemical processes and mechanical foaming.

Density is one of several factors that influence compressive strength. Other factors include: type of binder used, qualities of fine aggregate, mix proportions, methods of manufacture, type of accelerator used (if any), method of curing, etc. The material can be manufactured in densities of between 400 kg/m^3 and 1 200 kg/m^3.

As curing has a profound effect on the properties of cement, foamed cement should be thoroughly cured for a minimum of 14 d, with due consideration for the moisture content and shrinkage coefficients mentioned earlier.

To promote adhesion of waterproofing materials, a smooth sand-cement strip of width 450 mm should be provided along verges and around outlets and protrusions in the roof.

9.3.3 Materials

The more commonly used waterproofing materials, and also some general comments on them, are listed below. The manufacturers should be consulted with regard to specific products.

9.3.3.1 Bitumen-based materials

These materials include the materials given in 9.3.3.1.1 to 9.3.3.1.4.

9.3.3.1.1 Polymer-modified bitumen membranes

These membranes are based on mixtures of bitumen, polymeric compounds and fillers. The membranes are manufactured in sheet form and can contain reinforcements or can be applied to polymer-based carrier sheets.

The membranes are normally laid as single-layer systems and are loose-laid or fully bonded. The functioning of the systems depends on the efficiency with which the sheets are bonded together.

The membranes should be protected and the protective finish should be selected for specific materials.

The choices for certain materials are

a) compatible paint coatings (e.g. bituminous aluminium paint), **Amdt 2**

b) crushed stone layers,

c) paving blocks on sand or paving slabs on supports,

d) concrete or paving bricks, bedded in mortar,

e) paving slabs bedded in mortar, or

f) in-situ concrete paving,

the choice depending on the specific service conditions.

9.3.3.1.2 Bituminous felts

Bitumen-coated felts were used before polymer-modified bitumen membranes became available, but they may still be used. The base felts used in the current production of polymer-modified bitumen materials consist of cellulose, glass or synthetic materials (e.g. polyester). Figures 39(a) and 39(b) show two-layer and three-layer covering details.

9.3.3.1.3 Reinforced bitumen emulsion systems

(See 9.3.3.4.)

9.3.3.1.4 Mastic asphalt

This material can be covered with paving or provided with other surfaces for carrying traffic. The material can be applied to various details and configurations whilst still producing a continuous eamless waterproofing layer.

The material should comply with the requirements of SANS 297.

It is essential that an underlay be used ~~(see in 9.3.3.1(b))~~. **Amdt 3**

Mastic asphalt roofing should be protected and the protective finish should be specified, appropriate to the eventual function of the roof. The choices are

a) compatible paint coatings (e.g. bituminous aluminium paint), **Amdt 2**

b) crushed stone layers,

c) paving slabs on supports,

d) embedded slate,

e) slates or tiles bedded in mortar, or

f) in-situ concrete paving,

the choice depending on the specific service conditions.

9.3.3.2 Plastomeric membranes

Plastics such as polyvinyl chloride (PVC), polyisobutylene and chlorosulfonated polyethylene have been used with their attendant compounding materials and fillers to produce waterproofing materials. Their properties, even within the same class of polymer, can vary and it is normal for manufacturers to include (apart from the usual compounding materials) additives to improve flexibility, ultraviolet (UV) resistance and bacteriological resistance.

The materials are generally light in weight, are applied as single-layer systems and are loose-laid or fully bonded. A high degree of skill for their laying is required.

The materials offer a smooth surface which facilitates inspection and integrity testing. They are normally used without surface protection. Repairs are easily carried out by means of heat welding or solvent welding techniques.

9.3.3.3 Elastomeric membranes

Butyl rubber (complying with SANS 187), chloroprene rubber (complying with SANS 580) and EPDM (ethylene propylene diene monomer) systems have been used in the past. The sealing of overlap joints, with specific adhesives, requires a high degree of workmanship and skill.

9.3.3.4 Reinforced liquid applied systems

Membranes based on acrylic polymer (or modified acrylic polymer) binders reinforced with non-woven polyester or polypropylene fabrics perform well as waterproofing membranes and show good durability. These fully bonded systems require detailed specifications and strict supervision during application, in order to prevent malpractice.

Modified bitumen emulsions may also be reinforced with non-woven fabrics, but they require additional protection.

Tar-modified polyurethane resins may also be reinforced with woven or non-woven fabrics. Bleeding through the system is a disadvantage.

Chopped-strand glass-fibre mats have been used with polyester resins, and these systems perform well. They should be applied on an underlay.

9.3.3.5 Unreinforced liquid applied systems

Modified bitumen emulsions and tar-modified polyurethane resins are spray-applied without the incorporation of reinforcements. Monitoring the thickness of application, to ensure that a thickness in excess of the minimum is obtained, is difficult.

Any coating applied to concrete will improve its watertightness, but no coating can prevent leaks if the concrete cracks afterwards.

9.3.3.6 Self-adhering rubberized asphalt membranes

Self-adhering waterproofing consists of a single layer of pliable rubberized asphalt protected by an outer layer of high-strength polyethylene of total thickness approximately 1,5 mm. This is a fully bonded system that is reasonably easy to apply but that does require an activating primer.

NOTE The primer usually contains volatile flammable solvent, and suitable precautions should be taken in its use, especially in enclosed areas (e.g. lift pits, tanks, etc.).

9.3.3.7 Protection of waterproofing

Nearly all waterproofing needs protection against the destructive effects of the ultraviolet rays in sunlight. Many waterproofing systems can take light pedestrian traffic associated with building maintenance and need no protective surface.

Common forms of protection against pedestrian traffic and sunlight are tiles, slates, precast concrete slabs, clay paving bricks and concrete paving blocks, etc., the lighter units being set in bitumen or cement mortar, and the heavier units frequently laid loose. Light-coloured units aid thermal insulation by reflecting the sun's rays. Particularly useful are units (usually of precast concrete) with feet that raise them approximately 20 mm to 40 mm above the roof surface. The resulting air space provides considerable thermal insulation and also provides a path for the drainage of rainwater.

Where the roof will not be subjected to regular pedestrian traffic, protection can be provided by bitumen-based paints, preferably of the reflective type incorporating aluminium, or by covering with coarse sand or crushed stone. Sand and stone, however, accumulate dust, dirt and plant growth, while paint requires regular renewal.

NOTE Soft joints should be provided between paving and perimeter walls or any other protrusions.

9.3.3.8 Expansion joints

Where expansion joints are necessary in the deck supporting the waterproof coverings, care should be taken to make watertight joints. Expansion joints are usually placed at re-entrant angles of buildings and at intervals of not more than 18 m. The raised-kerb type is preferred, as illustrated in figure 40(a). Where flush joints are required, however, for example for vehicular traffic, the constructions shown in figure 38 can be used.

9.4 Trafficable roofs

9.4.1 Construction to suit pedestrian traffic

9.4.1.1 Suitable coverings

Suitable coverings comprise concrete paving blocks or clay paving bricks bedded in cement mortar or laid on a sand layer; concrete or clay tiles or slates bedded in cement mortar; in-situ concrete paving; embedded slates or tiles (for mastic asphalt coverings); and loosely laid paving slabs on supports.

9.4.1.2 Paving blocks, paving bricks, tiles or slates bedded in cement mortar

An isolation layer of polyethylene sheeting of thickness not less than 500 µm or an alkali-resistant geofabric of not less than 200 gm/m^2 should be provided over the waterproofing treatment as a protection against movement damage and to allow removal of the paving and mortar bed without damage to the treatment in the event of future repairs.

Construction details (including joints) for cement-sand mortar (not semi-dry cement-sand) should be in accordance with SANS 10109-2, except that a maximum isolation joint spacing of 3 m is recommended.

9.4.1.3 In-situ concrete paving

An isolation layer of polyethylene sheeting of thickness not less than 500 µm or an alkali-resistant geofabric of not less than 200 gm/m^2 should be provided over the waterproofing treatment as a protection against movement damage.

Construction details (including joints) for separate unbonded toppings should generally be in accordance with SANS 10109-2.

9.4.1.4 Embedded slates or tiles (for mastic asphalt coverings)

9.4.1.4.1 General

In roofs of this class, a type of mastic asphalt is used underneath a weather-resistant tiled covering.

9.4.1.4.2 Materials

The mastic asphalt used as the waterproofing portion of the composite roof covering should generally comply with SANS 297, and should consist of a mixture of not less than 13,5 % (by mass) of soluble bitumen with suitable graded mineral aggregate, formed into a dense impervious membrane that has a hardness number of between 30 and 50.

Asbestos cement, burnt clay, cast stone, concrete, metal, plastics, and slate have been used successfully as a tiled weather-resistant finish in this type of construction.

Details of application for slate embedded in mastic asphalt are as follows:

a) it is essential that an underlay be used, since it allows relative freedom of movement between the mastic asphalt and the deck;

b) one coat of mastic asphalt of thickness at least 10 mm is laid and, while the mastic asphalt is still hot, slates of approximate size 300 mm × 230 mm and that have guillotine-cut edges, are bedded in it, with the bevelled edge on the underside. Any mastic asphalt work left unfinished should be warmed up and cleaned at the edges before fresh material is laid adjacent to it;

c) joints are left full and flush with the slates; and

d) the type of joint used at the junction of the covering with upstands such as parapet walls, chimney stacks, etc., is illustrated in figures 35 and 37.

9.4.1.5 Loosely laid paving slabs on supports

Approved spacer pieces should be used under supports or under five-point slabs in order to prevent damage caused by the pressure of tiles over long periods to the waterproofing treatment.

Provision should be made for isolation joints at 3 m intervals and along the perimeter and at points of potential stress concentration (see figure 38(a)).

9.4.2 Construction to suit light vehicular traffic

9.4.2.1 Suitable coverings

Suitable coverings comprise in-situ concrete paving, concrete paving blocks, clay paving bricks, and concrete paving slabs bedded in mortar.

9.4.2.2 In-situ concrete paving

The design and construction details should generally be in accordance with 9.4.1.3.

9.4.2.3 Concrete paving blocks, clay paving bricks and paving slabs (450 mm × 450 mm) bedded in cement mortar

The design and construction details should generally be in accordance with 9.4.1.2 (see figure 39(b)).

NOTE Asphalt surfacing is **not** recommended because of its vulnerability to damage by oil, petrol, etc.

9.4.3 Roof gardens and planters (for shallow root system plants only)

9.4.3.1 Surface preparation

Concrete screeds and masonry surfaces should be dry, firm, even, smooth and free from loose aggregate, sharp protrusions and edges. Honeycombing and uneven areas should be rectified to obtain a smooth surface. Brickwork should be straight, with flush joints. Junctions of the floor and roof should be coved. Screeds should consist of cement-sand mortar in accordance with 8.5.2.2.1 of SANS 10109-2.

To facilitate bonding of the waterproofing to outlets, outlets should have a flange of at least 100 mm.

9.4.3.2 Priming

All vertical and horizontal surfaces to which the waterproofing will be applied should be treated with an appropriate primer.

9.4.3.3 Application of the waterproofing treatment

The waterproofing treatment should be bonded to the primed vertical and horizontal surfaces. Overlaps in the waterproofing should be waterproofed. When more than one waterproofing treatment is employed, laps should be offset from those in the initial treatment, and waterproofed. Adequate protection against root growth should be provided.

9.4.3.4 Protection

All surfaces should be protected from mechanical damage (e.g. by garden forks, spades, etc.). Suitable protective measures include a brick skin or unpressed asbestos-cement boards, for vertical surfaces, and a layer of unpressed asbestos-cement tiles or boards of suitable thickness attached with bituminous putty, or reject cement tiles, or cement-sand mortar, for horizontal surfaces.

If a filter bed of stone in layers of various sizes is to be used, the stone should be provided directly over the protective systems, followed by filter cloth and garden soil (see figure 41).

9.4.4 Standing water test

It is prudent to insist on a standing water test on all waterproofed flat roofs and planters. The duration of such a test should be at least 72 h. This test should be repeated when the waterproofing has been covered with stone or paving. Only if no unexplained drop in water level occurs and no leaks are visible can it be concluded that the roof is waterproof.

NOTE Ensure that the manufacturer is involved for the duration of the tests.

9.5 Drainage of roofs

9.5.1 General

For conventional building the critical period for a rain storm is very short (normally considered to be 5 min). The rainfall areas in South Africa can be divided into three basic zones from a meteorogical point of view, namely, summer rain, winter rain and all-year-round rainfall areas. (See SANS 10160 (parts 1 to 8)). **Amdt 3**

Critical gutter and downpipe designs should therefore be properly calculated (see figure 43). In certain areas, account should be taken of hail, which tends to block the gutters and downpipes. Dirt and leaves can cause blockage of gutters and downpipes, and special precautions should be taken, and regular maintenance is advisable. It is prudent to provide overflow gargoyles in the design wherever possible, as a solution in the event of a potential “flash storm”.

In the case of sloping roofs, the overflow from the eaves gutters that falls free from the building will usually not affect the building or its contents. On the other hand, in the case of valley and box gutters, any overflow can result in serious damage to the building and its contents.

In the case of flat roofs, ponding is often responsible for water penetration into the building where waterproofing membranes or flashings (or both) are either punctured or inadequate.

The waterproofing material should always be dressed up against any vertical surface for a minimum distance of 150 mm and dressed down in gutters, downpipes, etc., for a minimum distance of 100 mm (see figures 37, 39 and 40).

The concept of peak flow reduction of stormwater by “storage ponding” is employed by a number of overseas countries to reduce the high initial flows experienced during flows of high intensity but of short duration. This method is not often used in South Africa and would entail special attention to the waterproofing and design of such roofs.

Gutters should be laid to a fall of at least 1 in 500. Deflections owing to load can result in ponding, which is undesirable, because this in turn, could lead to the formation of silt deposits.

9.5.2 Rough guide to sizing of gutters and downpipes

(See figure 43.)

9.5.3 Downpipes

External downpipes are preferred to cast-in or built-in downpipes with regard to maintenance, replacement, cleaning, damage potential and overflow facility.

A very important point sometimes overlooked by designers is that the inlet to the downpipe might act as an hydraulic control and that spillage could then result at the head of the gutter. It is therefore important to provide a receiver box or suitably designed tapered section at the top of the downpipe to ensure that the water in the gutter flows freely. Conical heads can be used to decrease the driving head required and the diameter of the top of the conical frustum should generally be at least 1,5 times the diameter of the downpipe, and the depth of the tapered portion, at least 0,75 times the diameter of the downpipe (see figure 42).

The effective capacity of a downpipe is almost invariably limited by its inlet conditions. Adequate anchorage against pressure forces should be provided at all bends. The provision of overflow weirs, where possible, is recommended.

9.5.4 Hail guards

Hail guards are generally multifunctional and are fitted for one or more of the following reasons:

a) as hail protection;

b) as walkways;

c) as outlet protection; and

d) as protection against leaves and wind-blown debris.

9.5.5 Drainage of canopies

Canopies can have a flat or pitched roof construction, but are usually flat, and water from canopies can be a nuisance if it is allowed to drip over the edges of the construction. It should be drained away to a gutter or outlet. Figure 40(b) shows a typical detail.

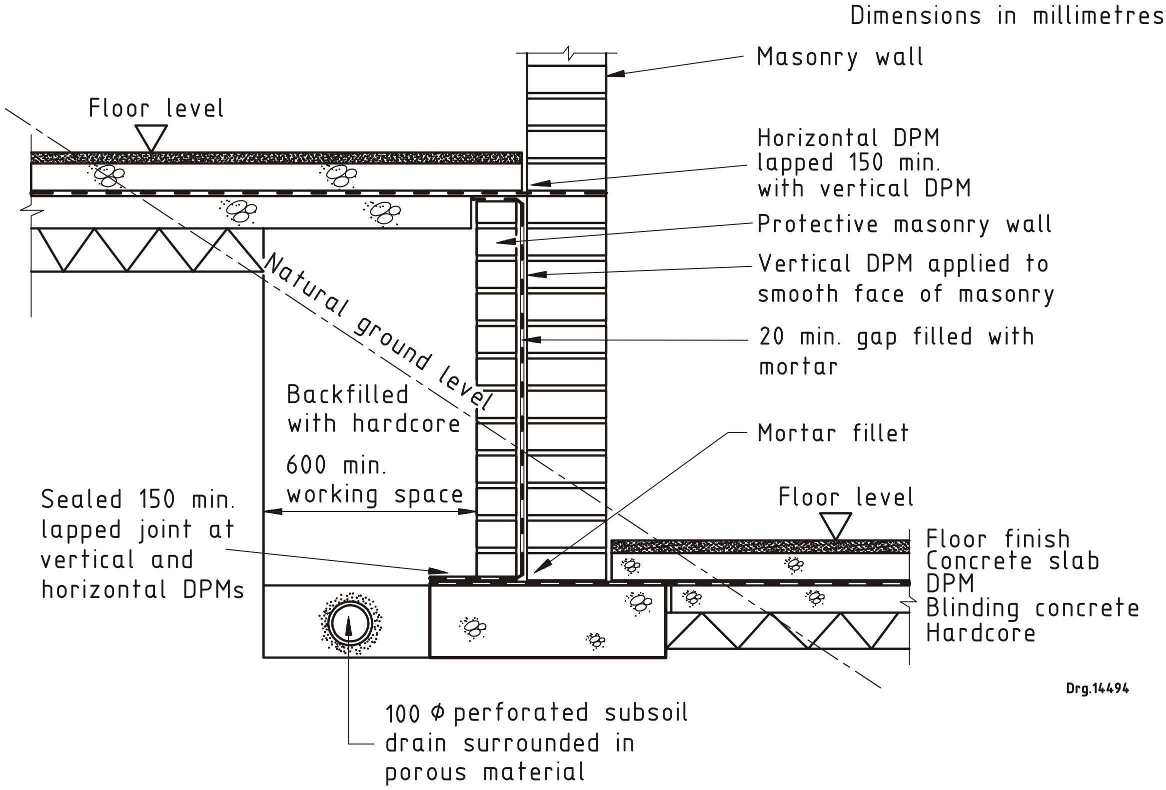


Figure 1 — Damp-proofing for stepped construction on sloping ground

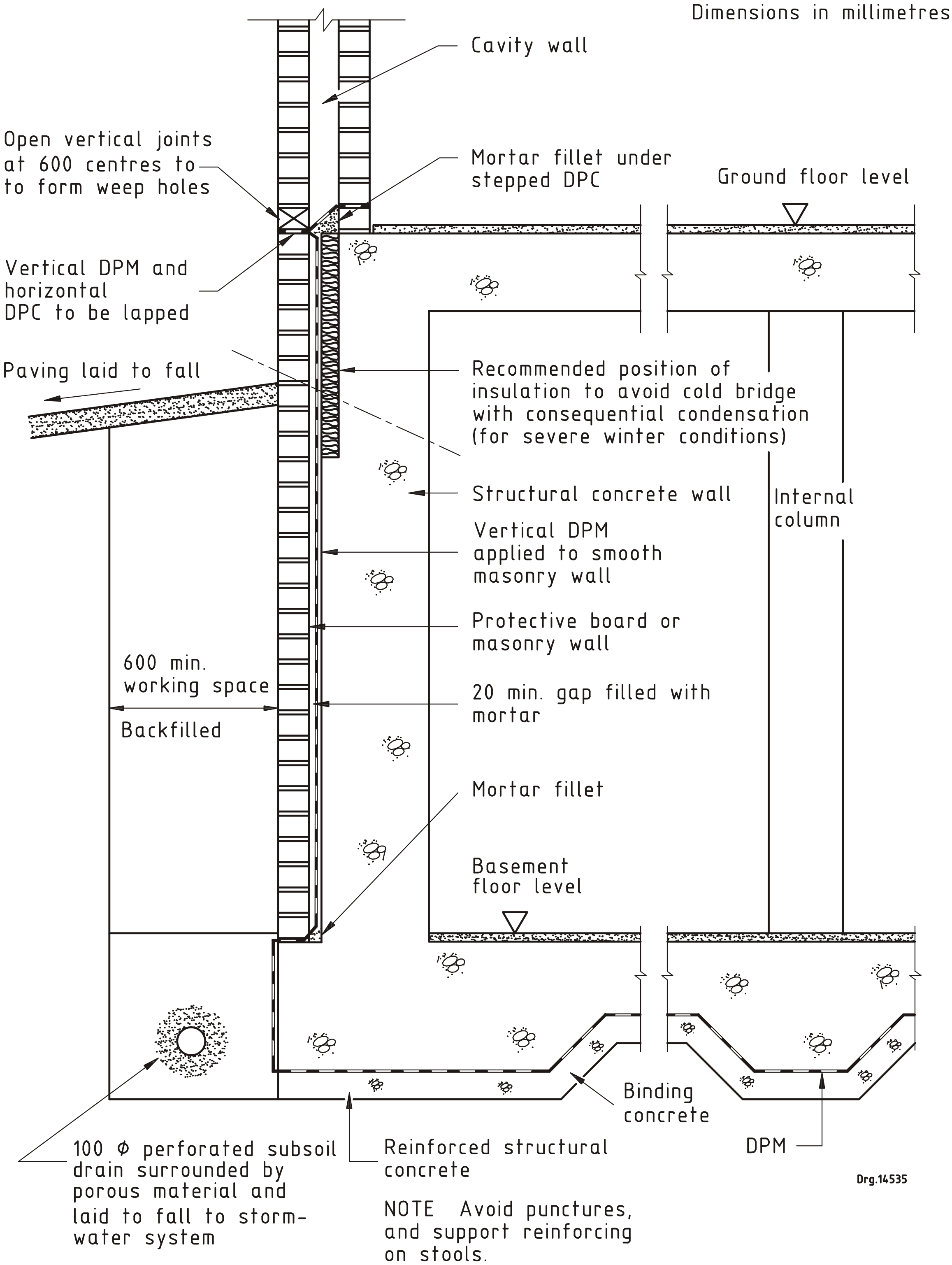


Figure 2 — Externally tanked concrete basement with pressure relieving drain

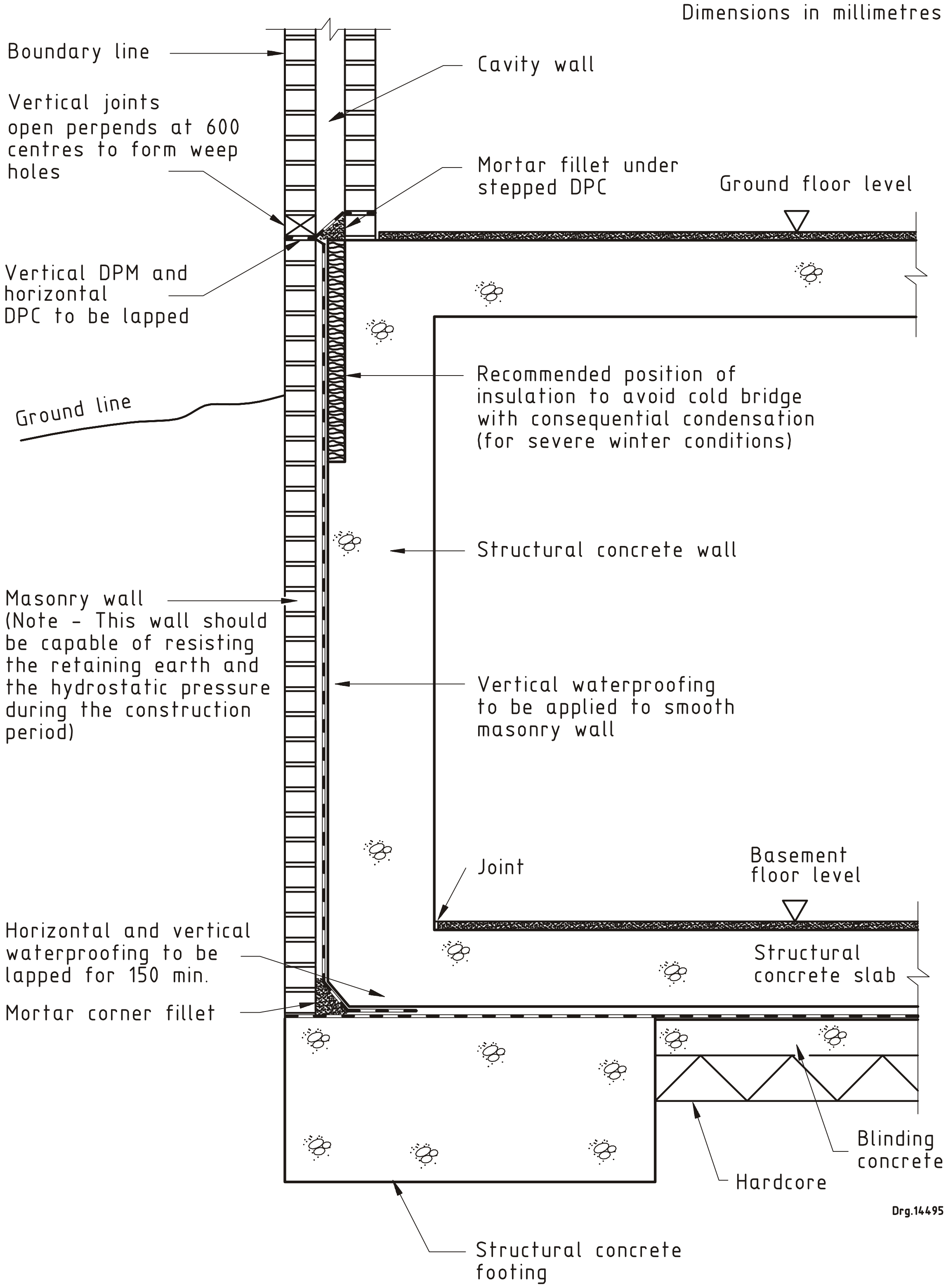


Figure 3 — Internally tanked concrete basement

Dimensions in millimetres

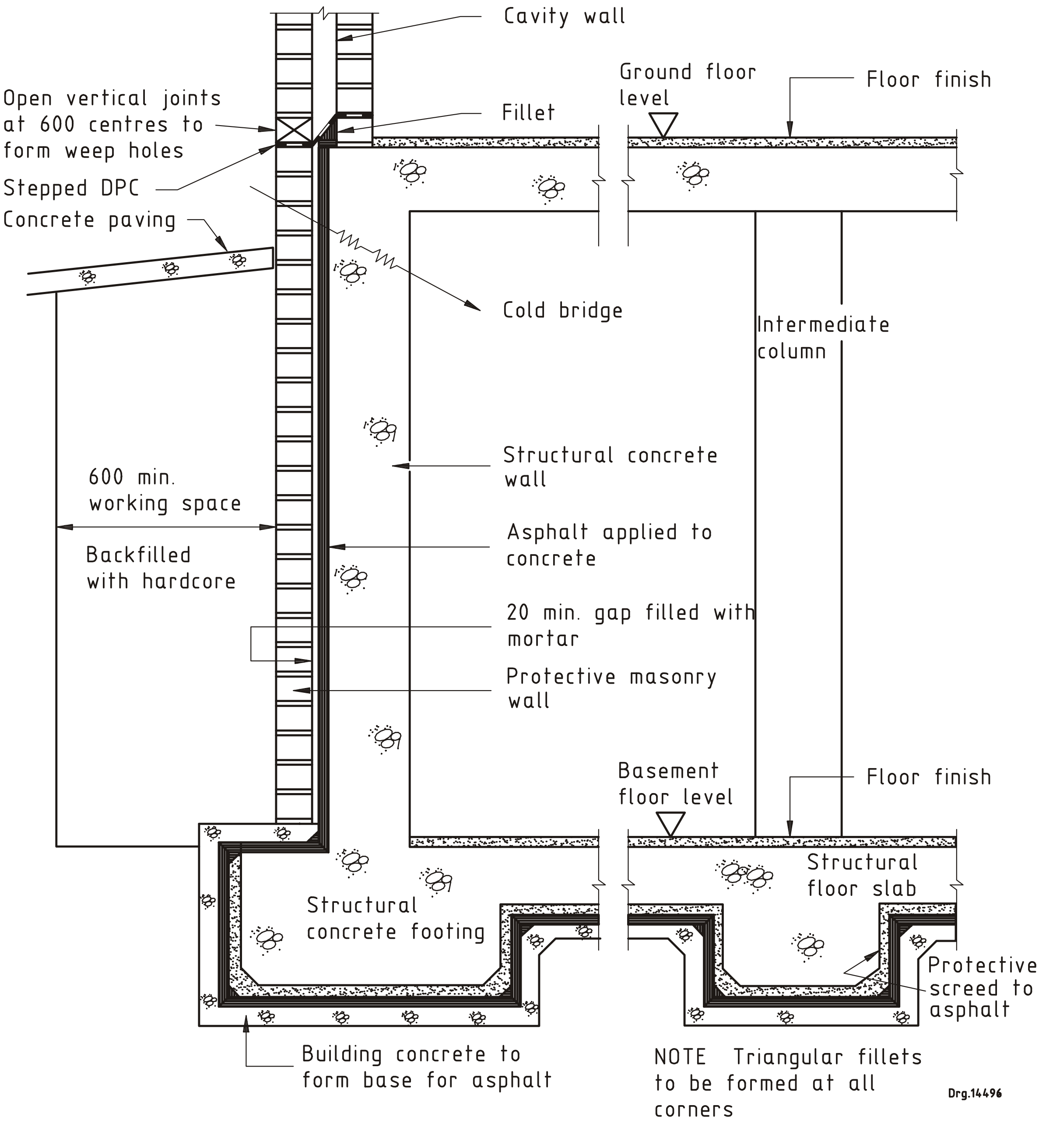


Figure 4 — Asphalt tanking applied externally including column bases

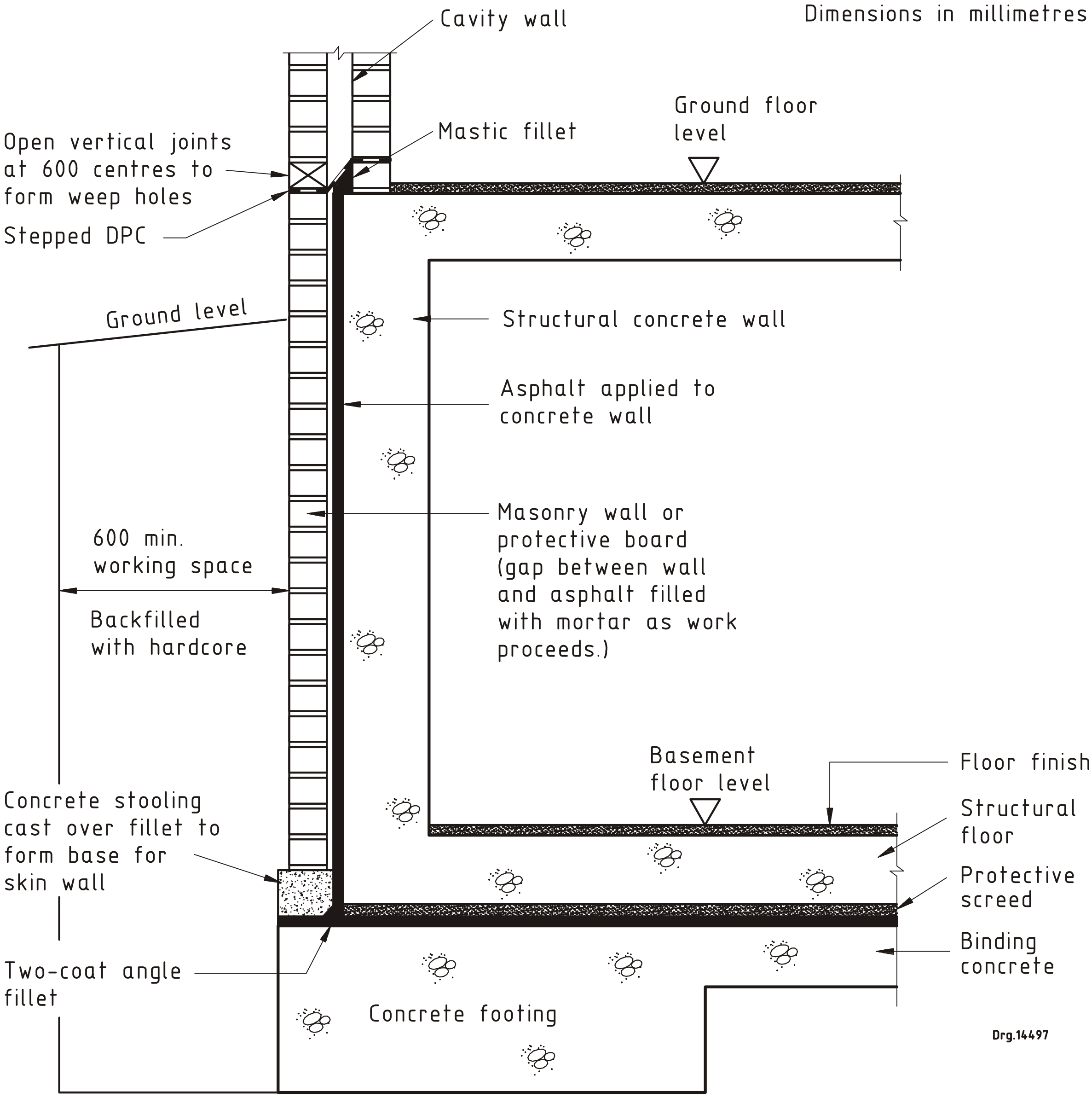


Figure 5 — Asphalt tanking applied externally

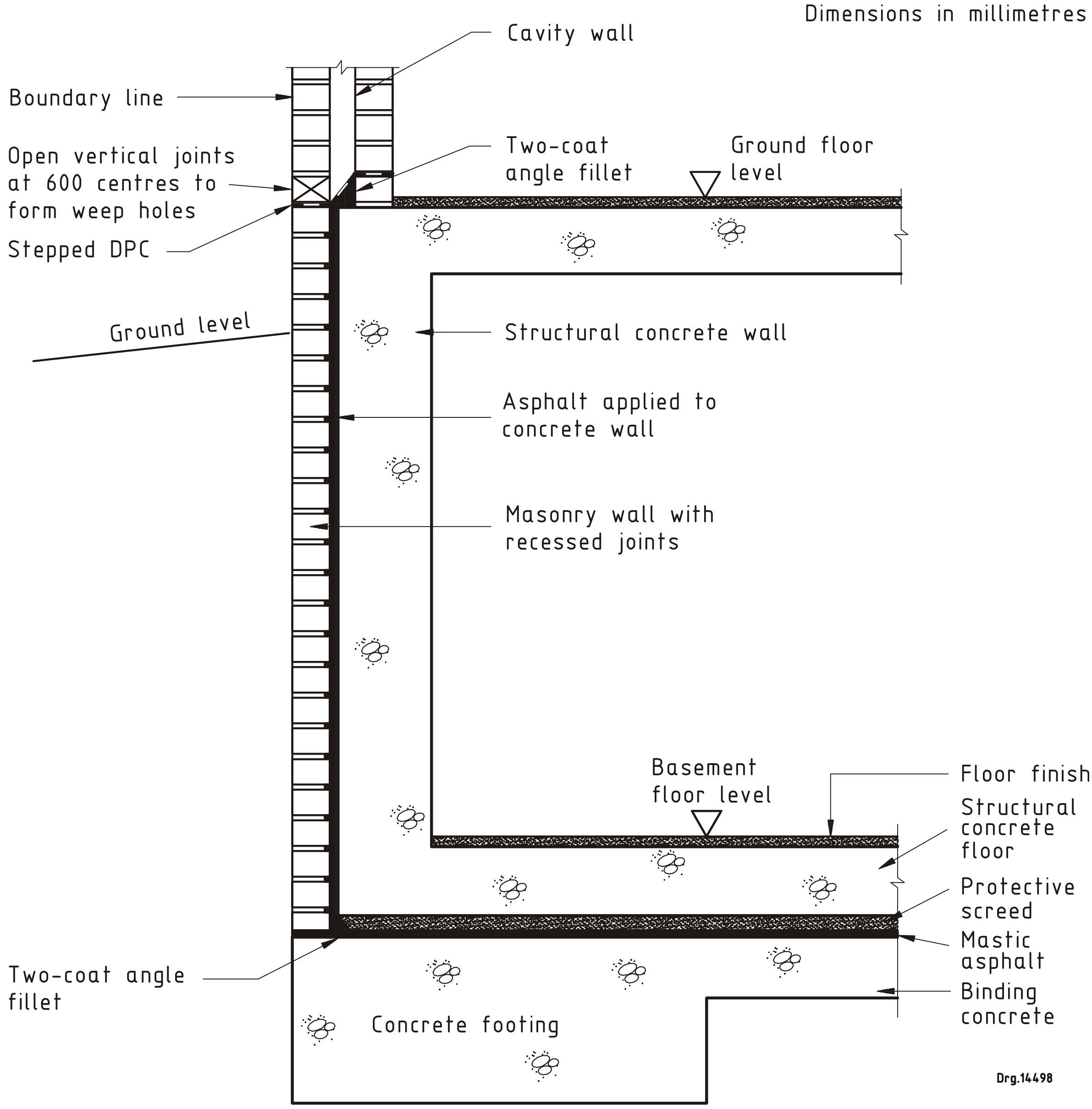


Figure 6 — Asphalt tanking applied internally

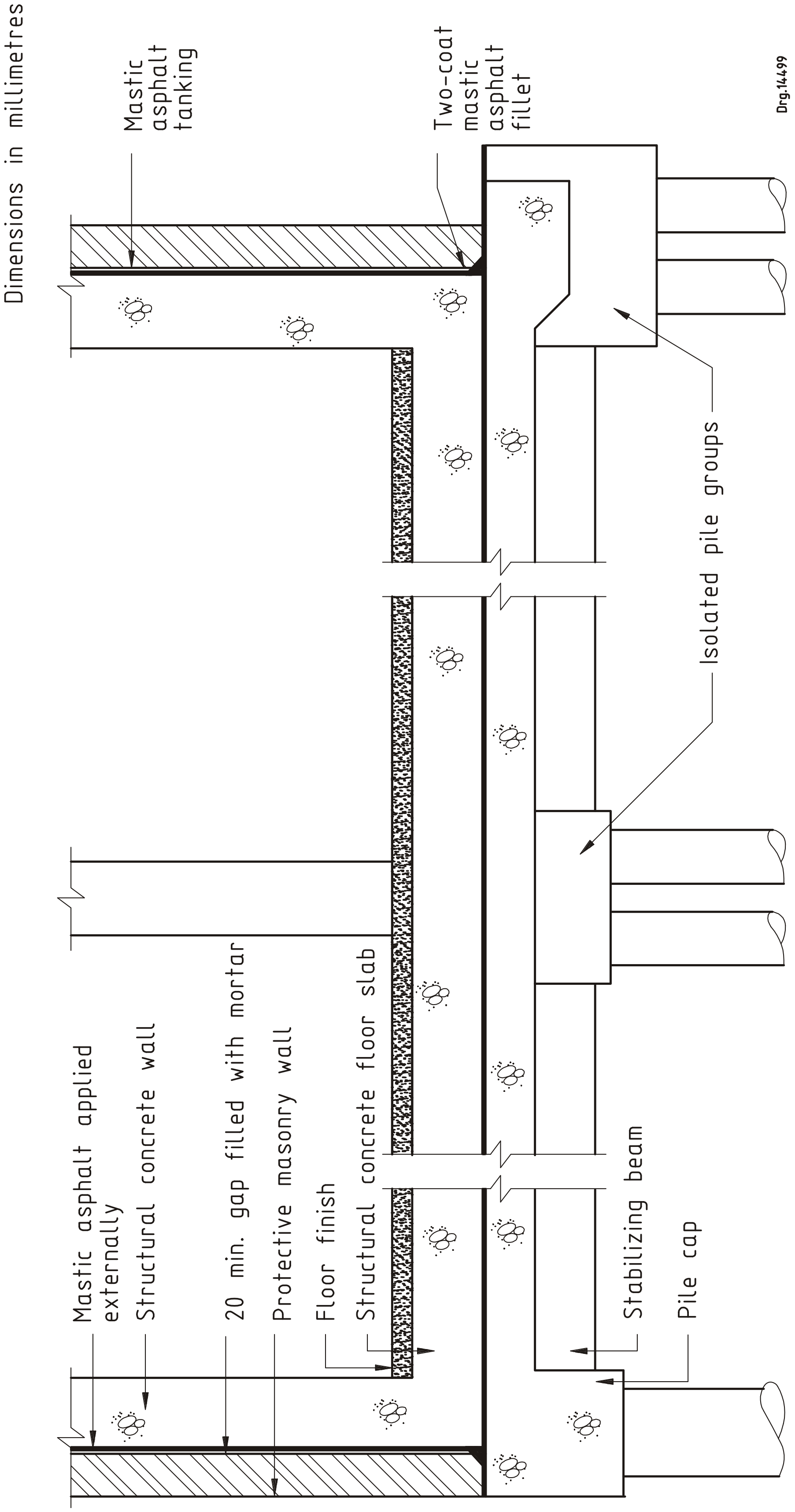
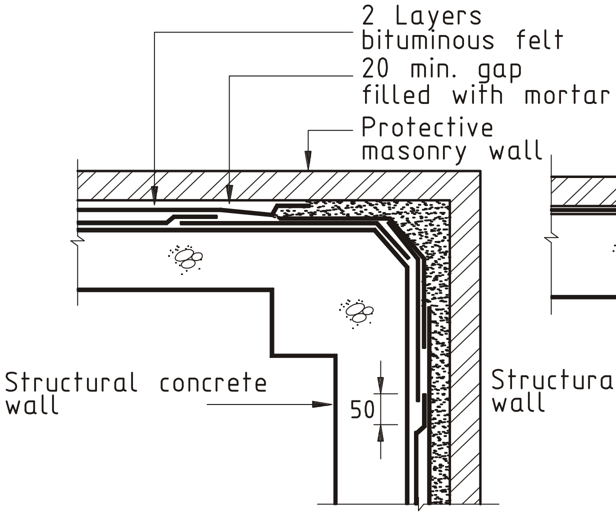
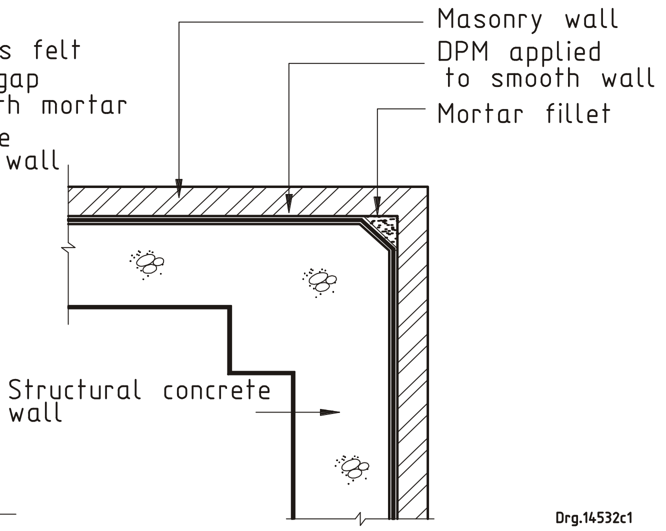


Figure 7 — Tanked concrete basement carried on piles

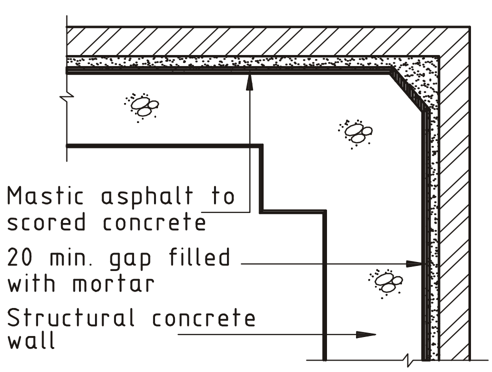
Dimensions in millimetres



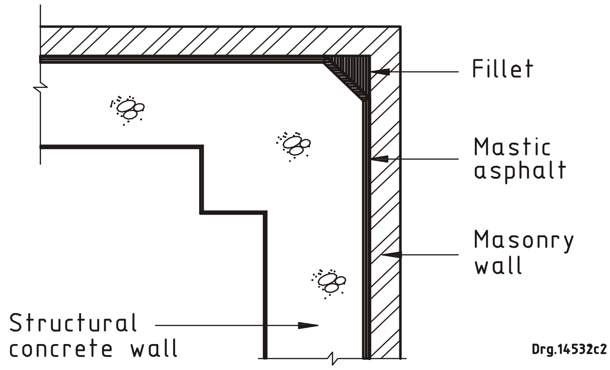
a) **Bituminous felt applied externally**



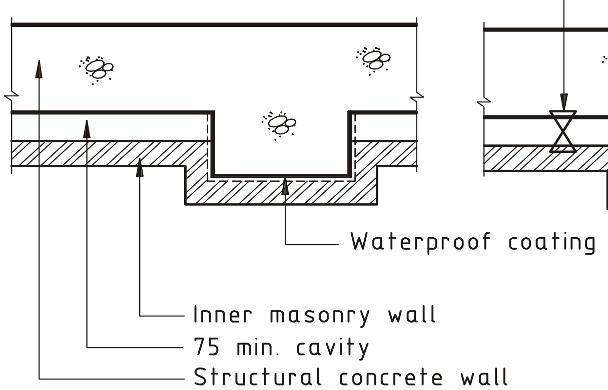
b) DPM applied internally



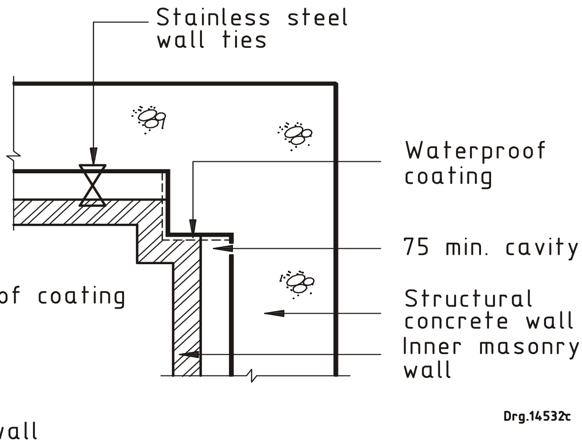
c) Mastic asphalt applied externally



d) Mastic asphalt applied internally

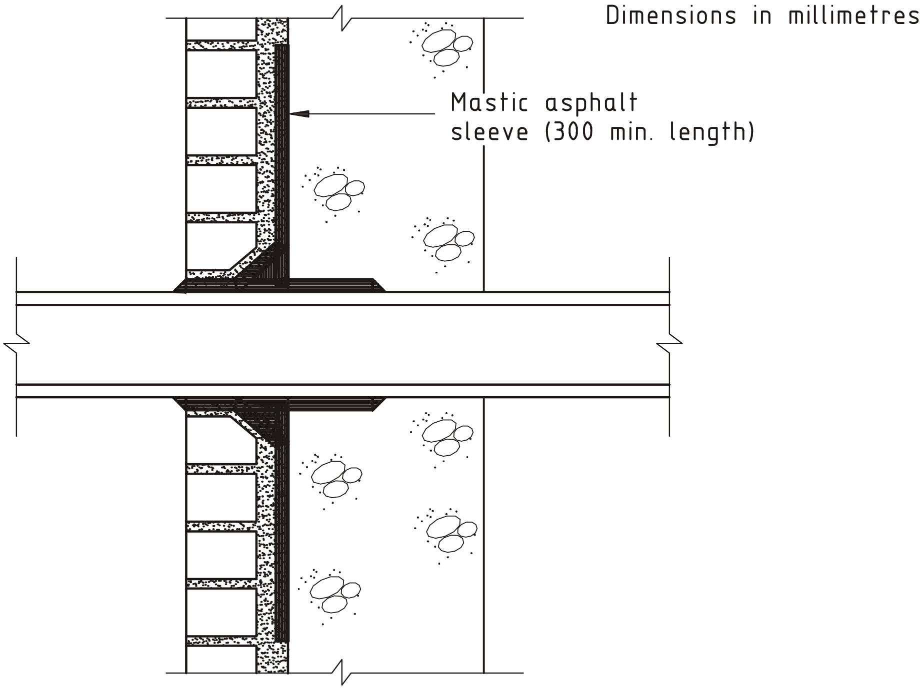


**e) Cavity construction
(intermediate column)**

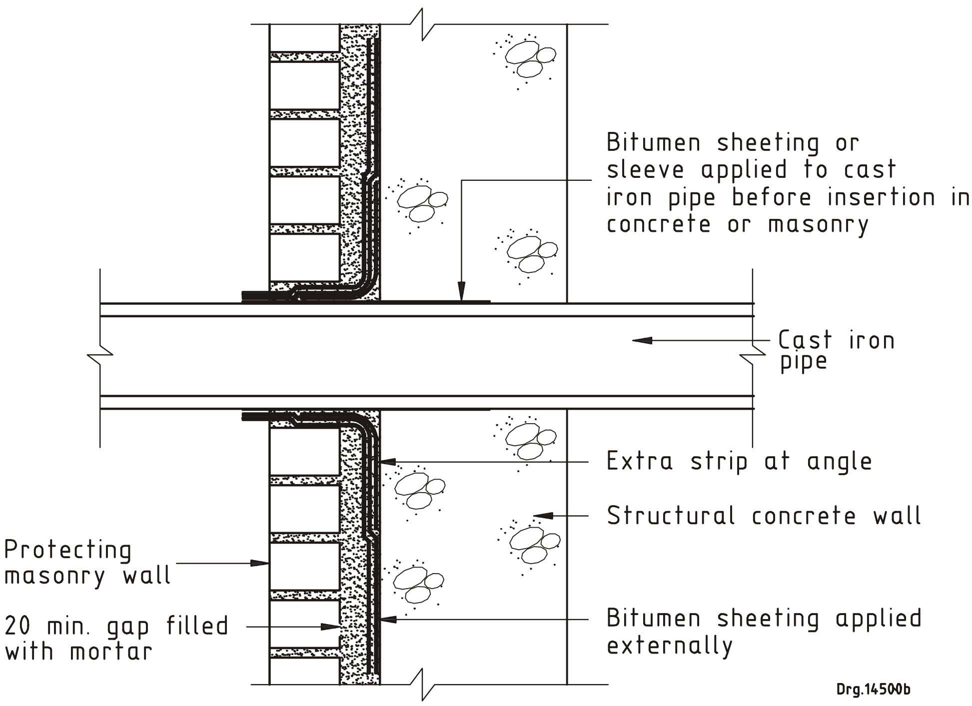


**f) Cavity construction
(corner column)**

Figure 8 — Typical basement corner details



a) Asphalt tanking



b) Bitumen sheet tanking

Figure 9 — Treatment of pipes passing through tanked basement walls

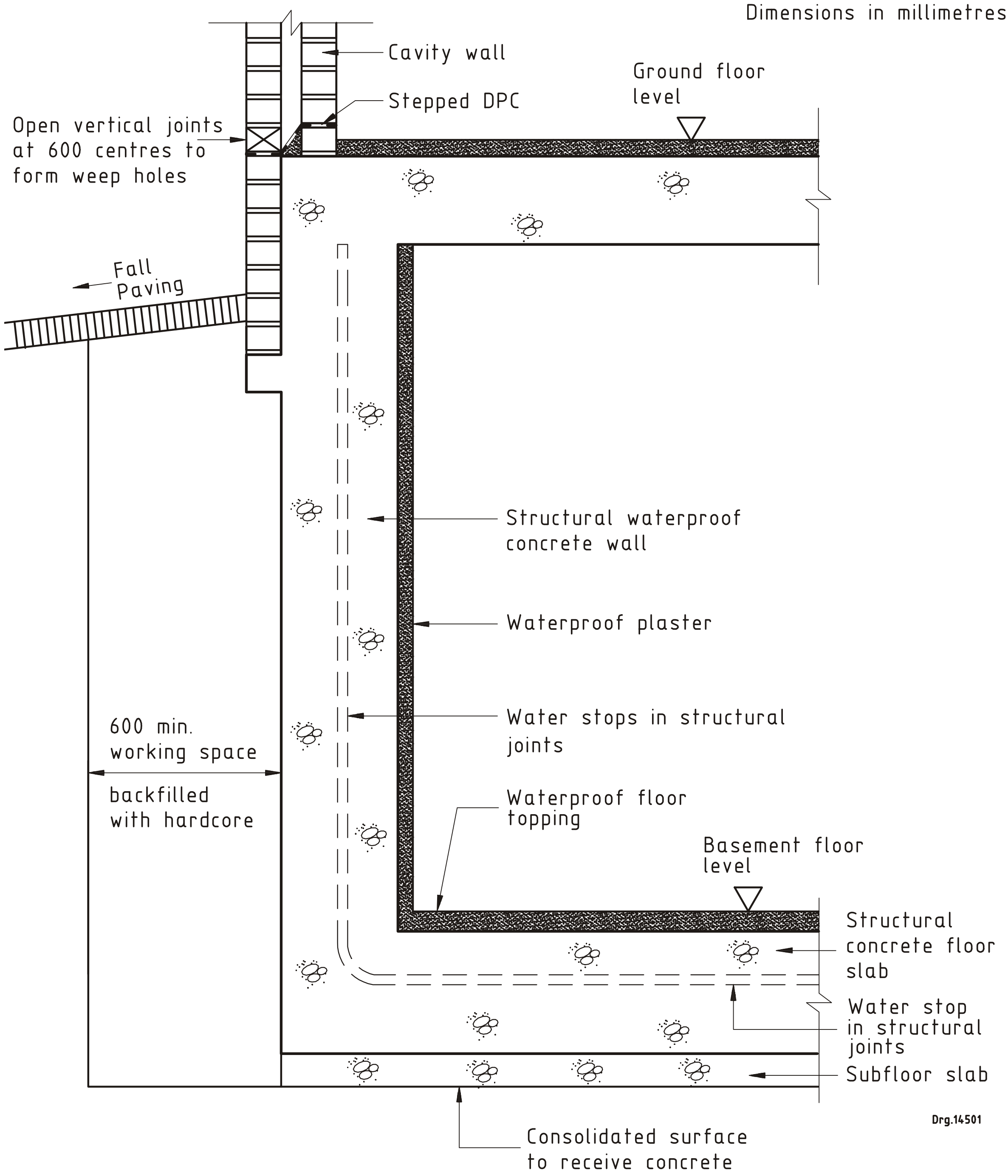


Figure 10 — Waterproof concrete construction

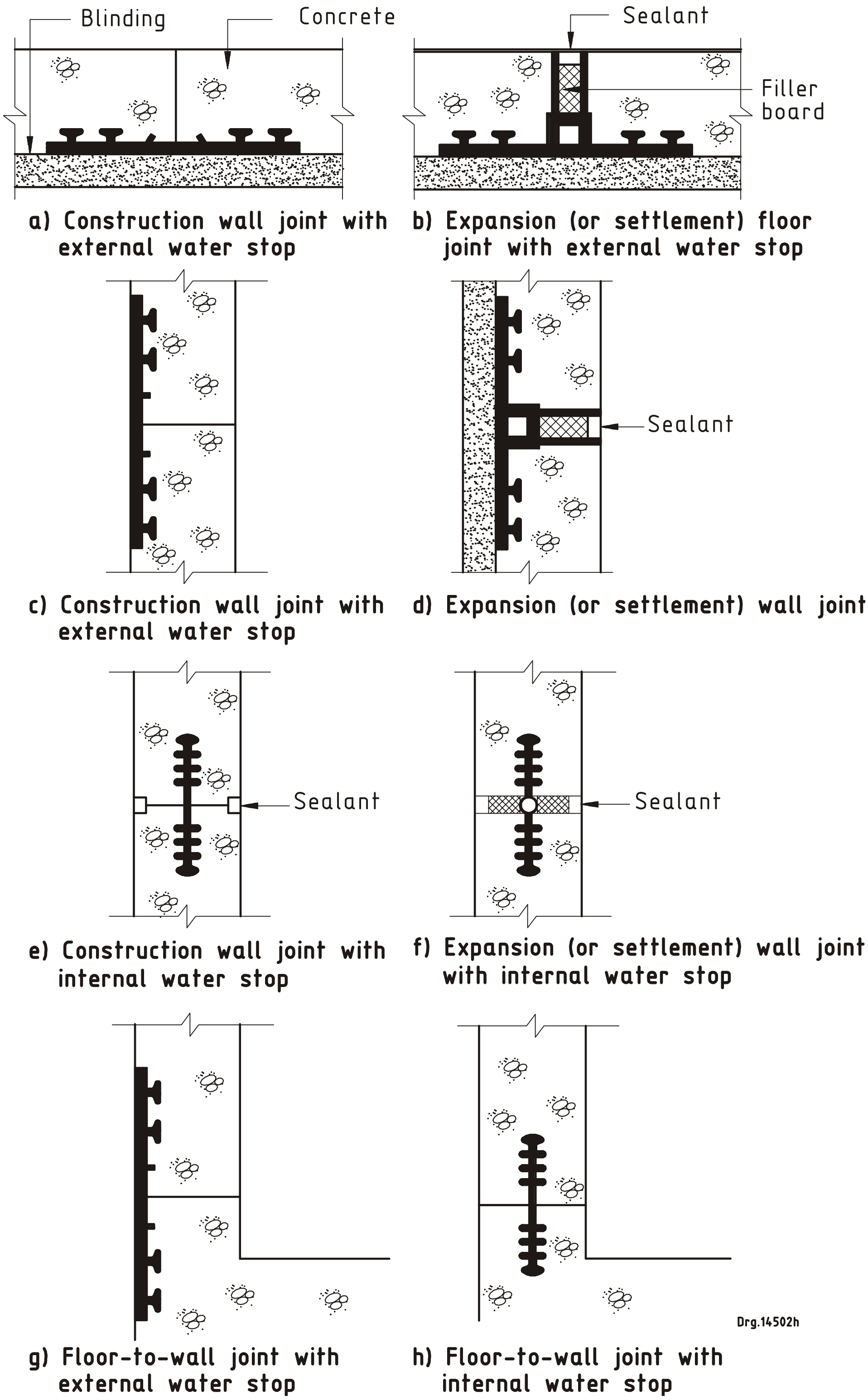


Figure 11 — Typical applications of water stops

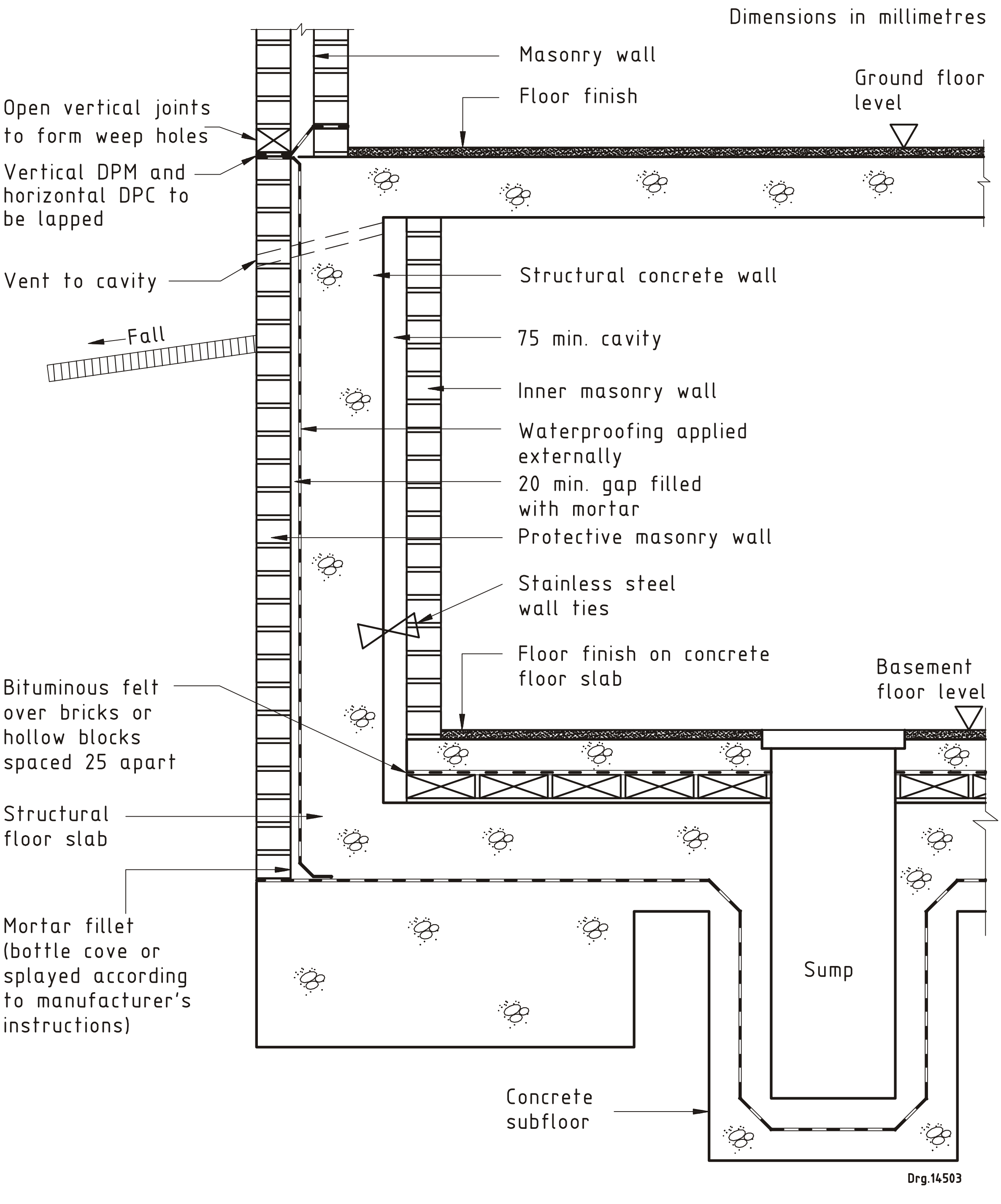


Figure 12 — Combined tanking, cavity and drainage construction

Dimensions in millimetres

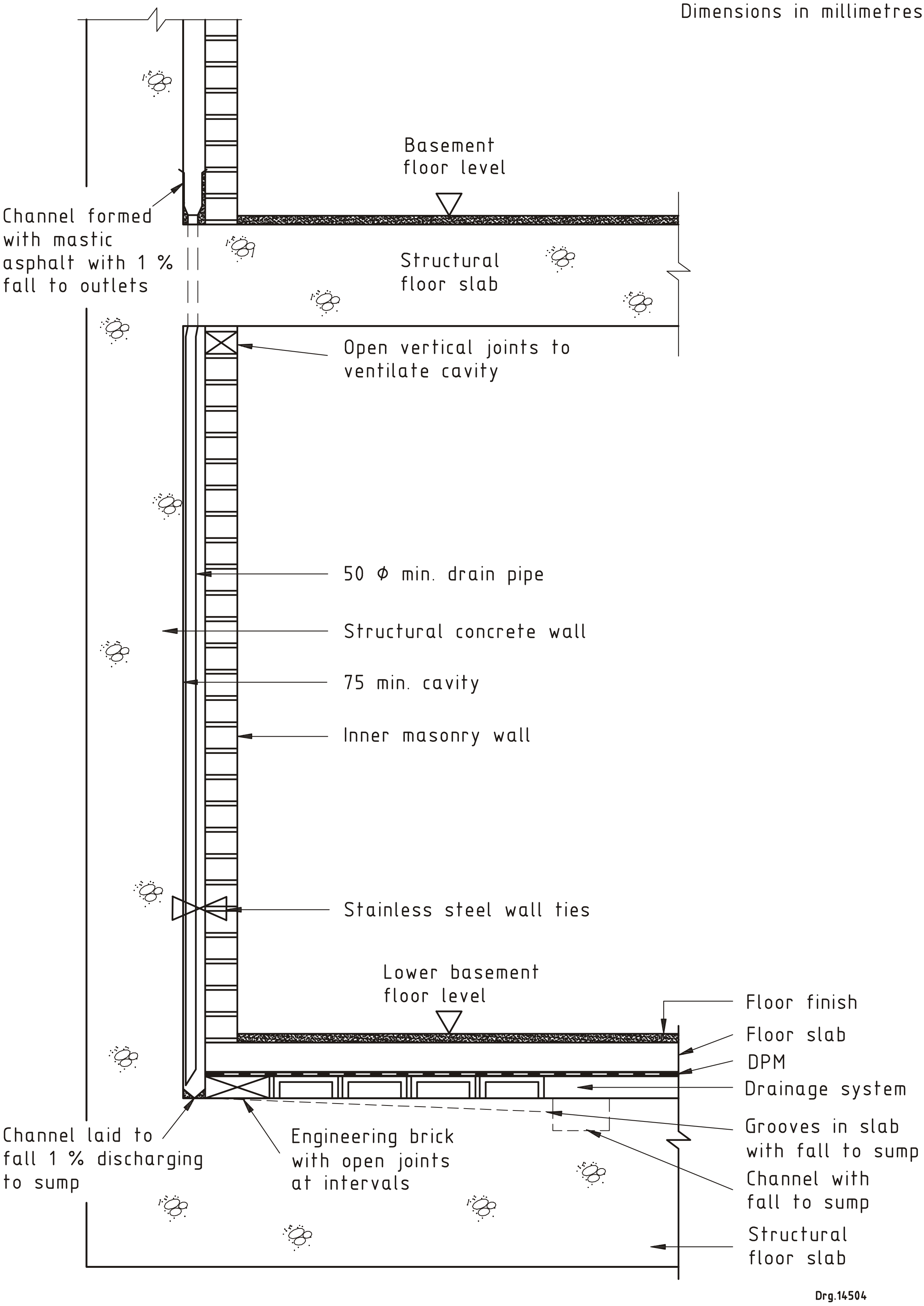


Figure 13 — Drained cavity construction

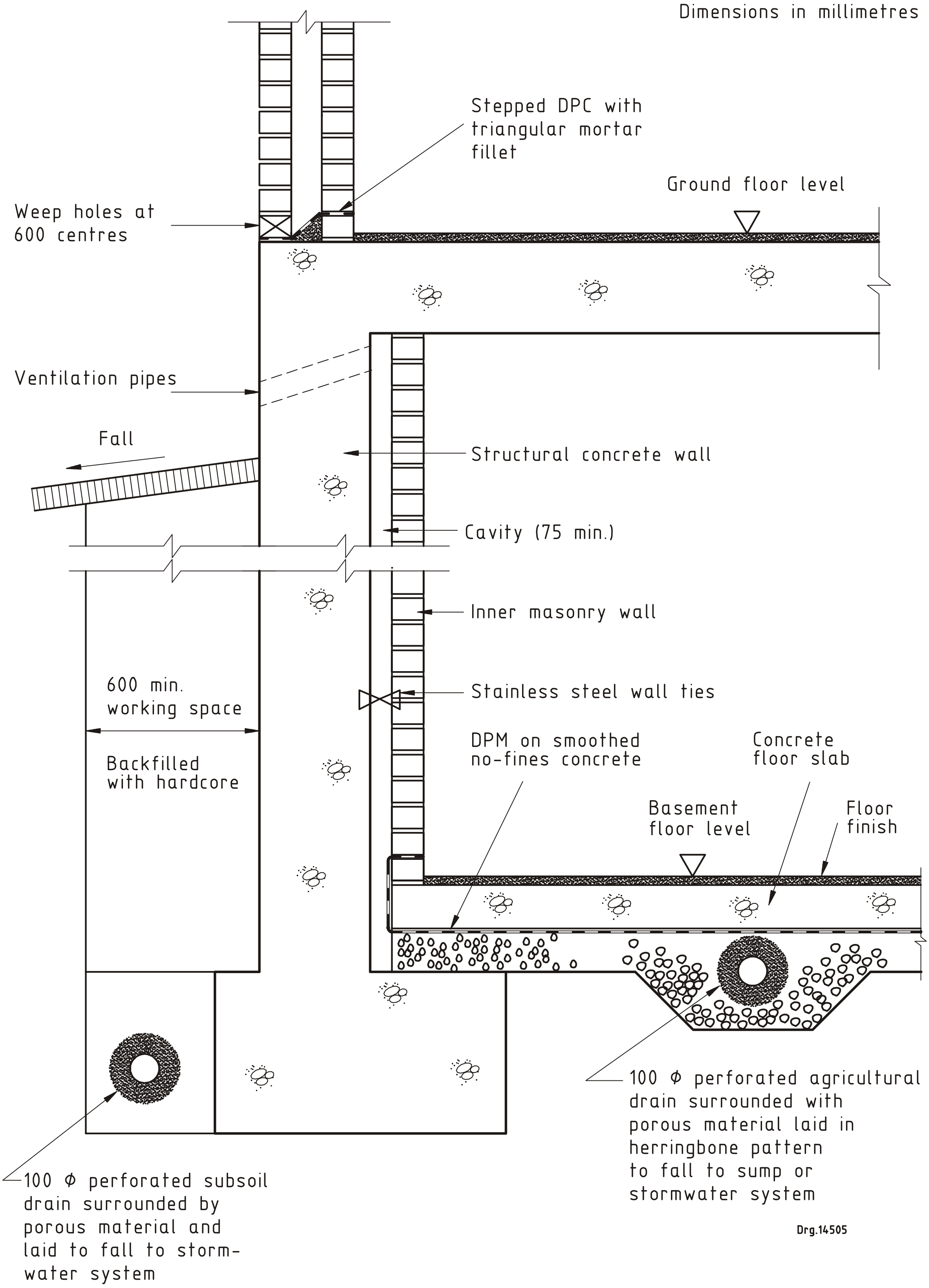
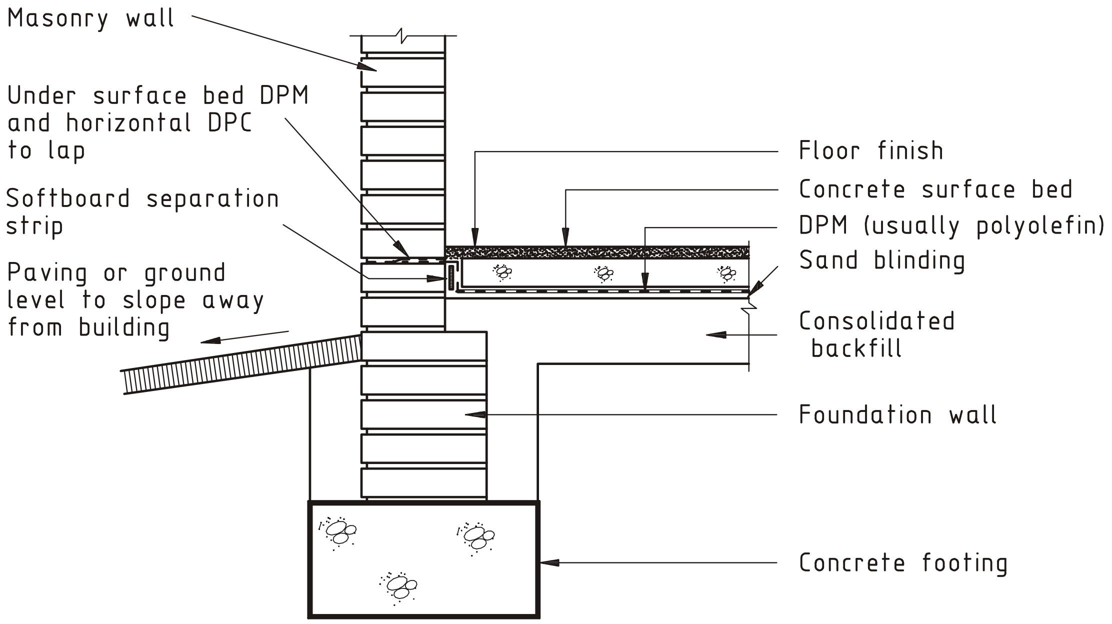
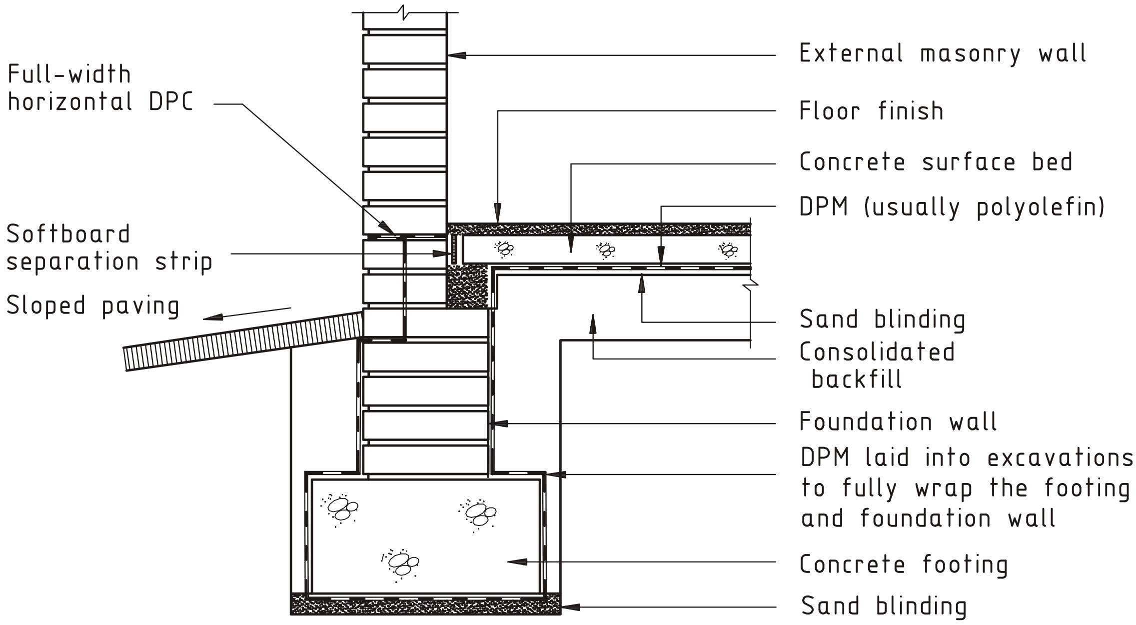


Figure 14 — Cavity basement construction with under-floor drainage



a) Dry conditions



b) Wet conditions

Figure 15 — Damp-proofing to external walls and surface beds

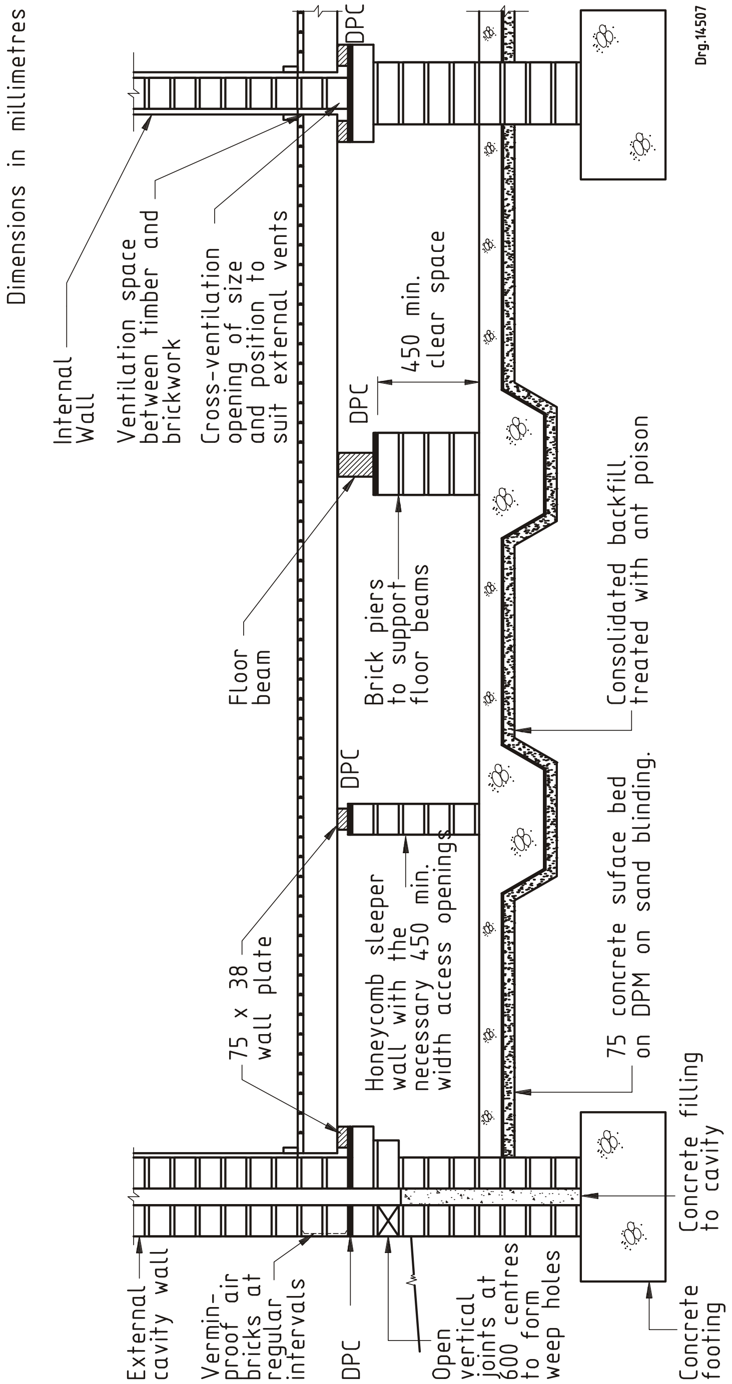


Figure 16 — Suspended timber floor on concrete surface bed

Figure 17 Deleted by amendment No. 2

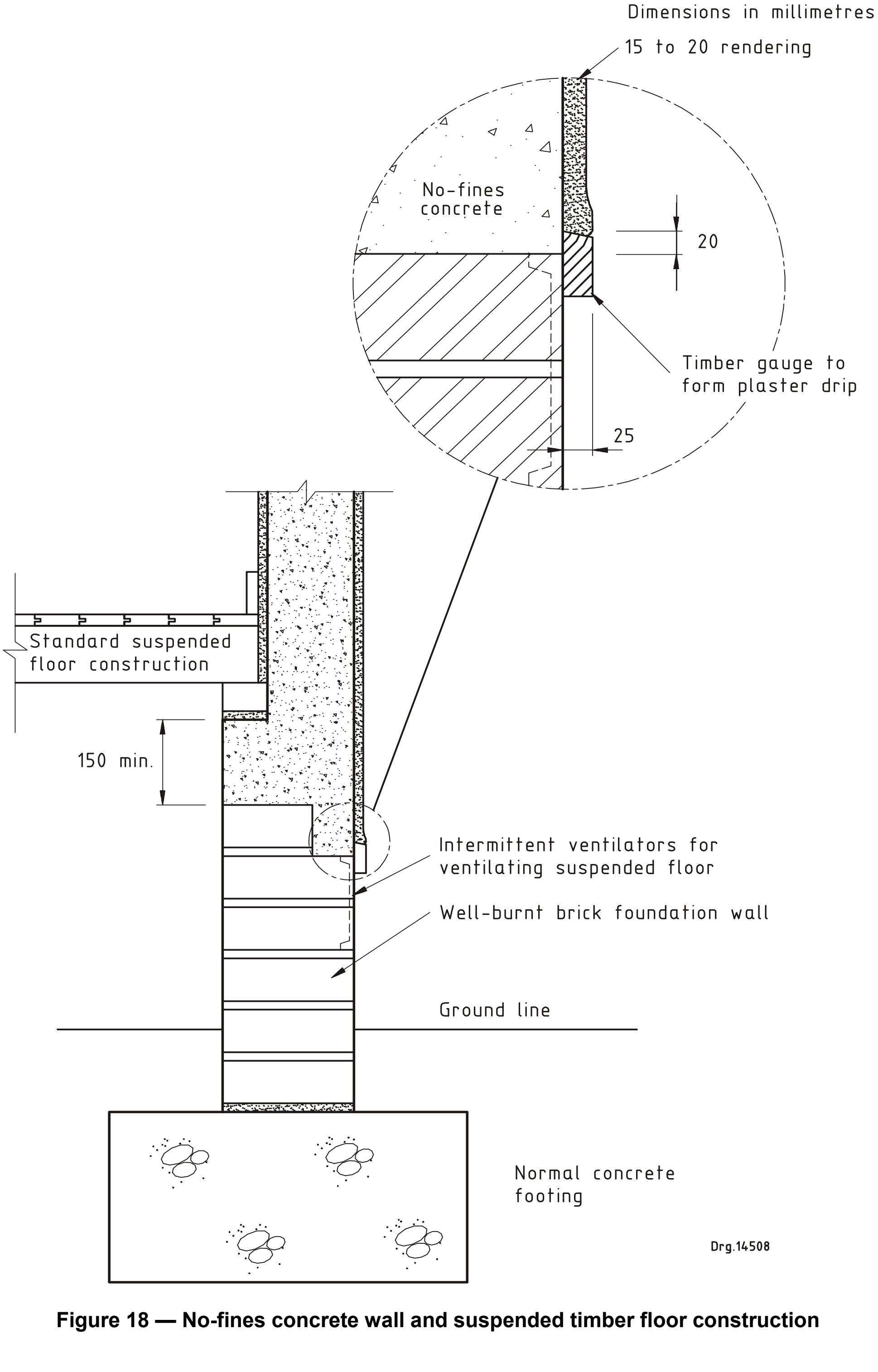


Figure 18 — No-fines concrete wall and suspended timber floor construction

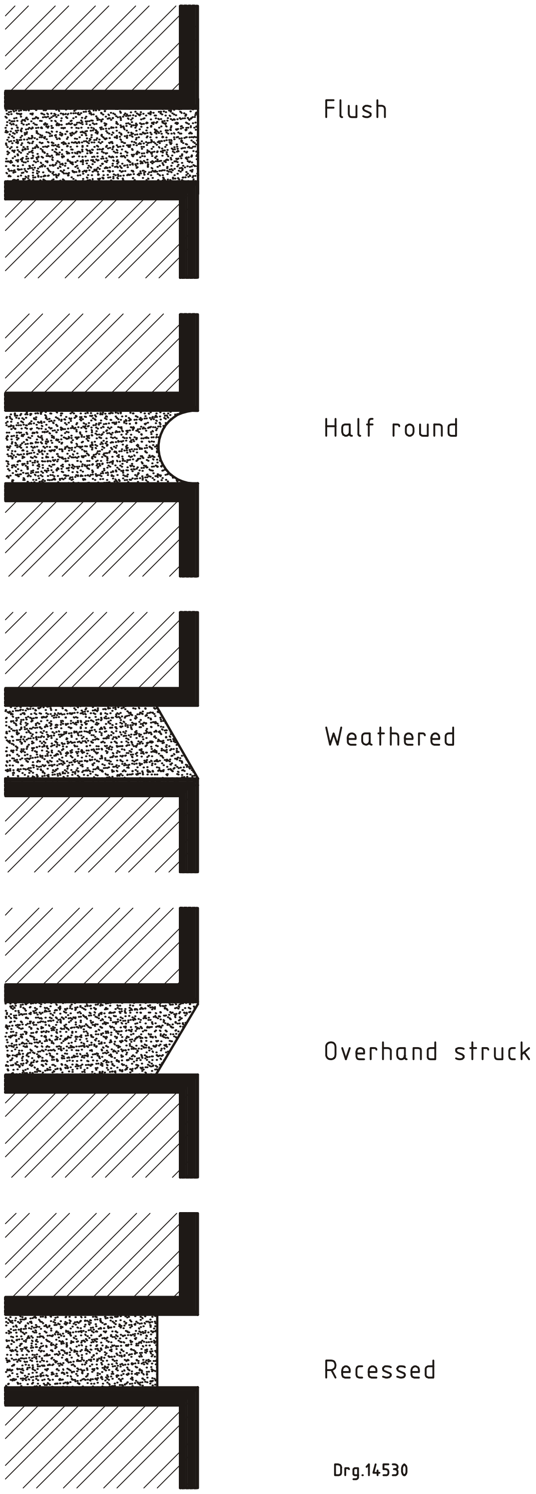


Figure 19 — Types of masonry joints

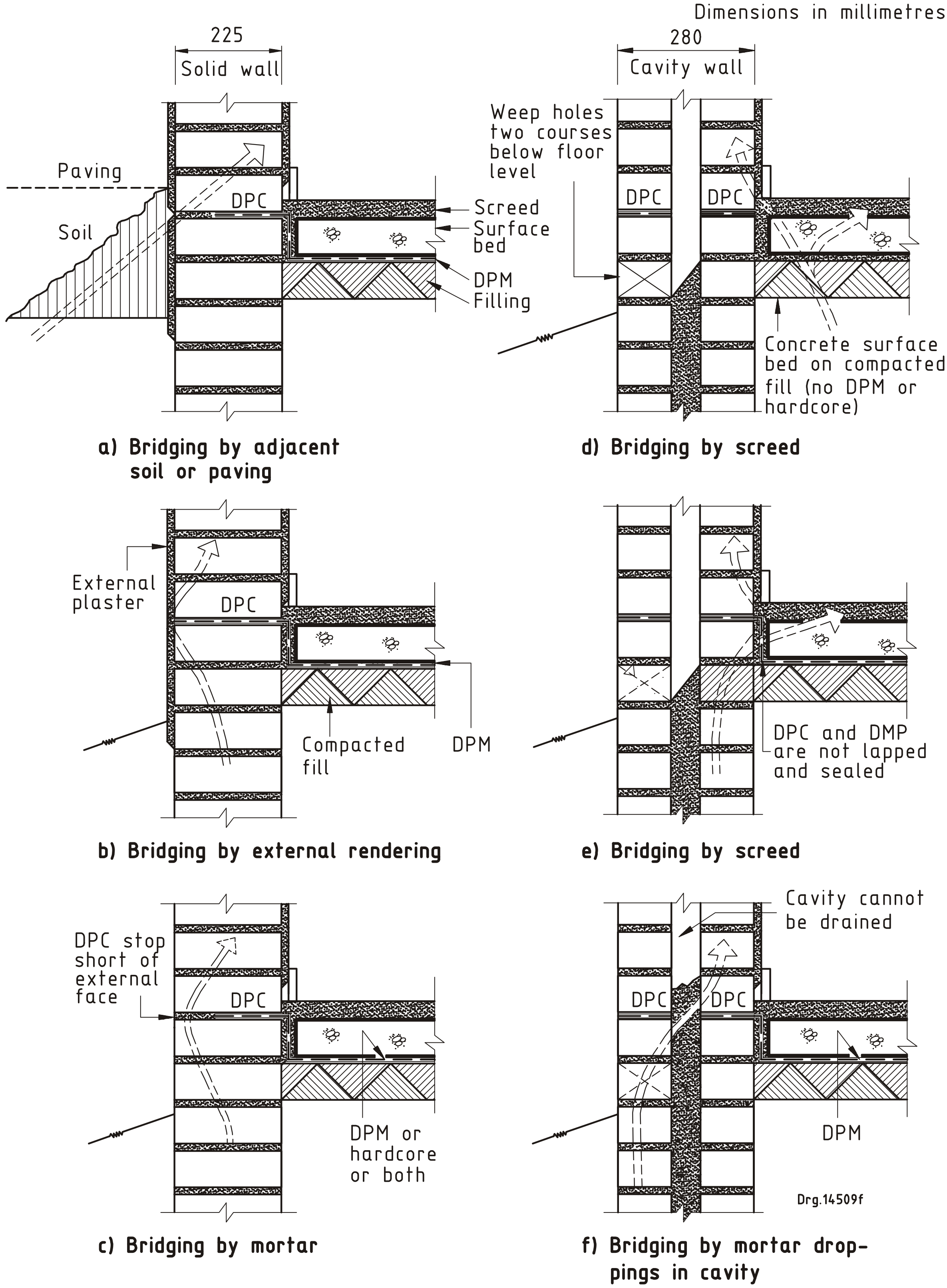
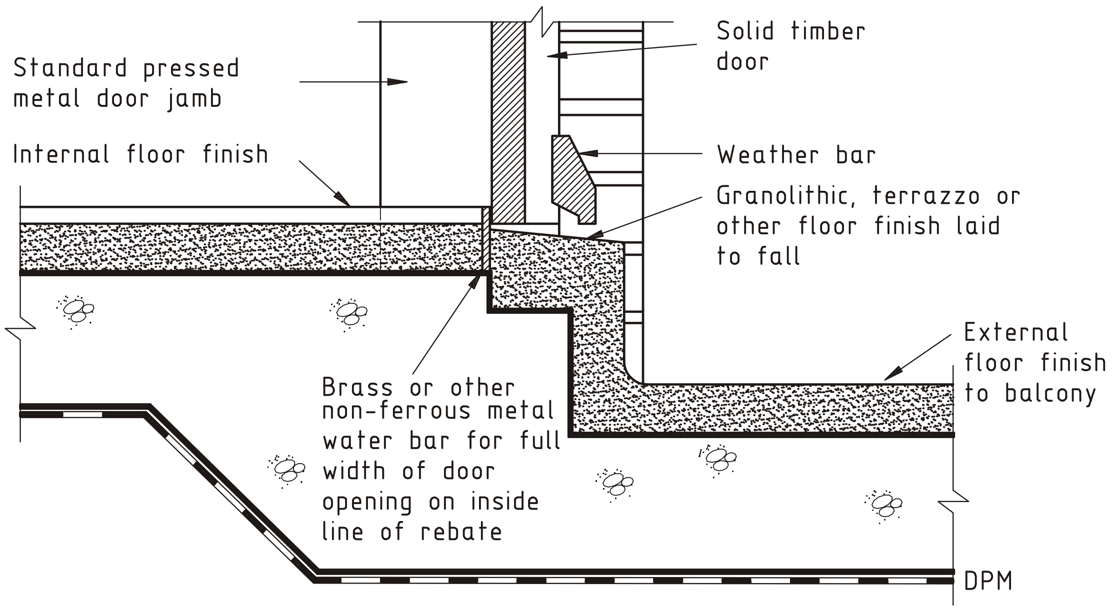
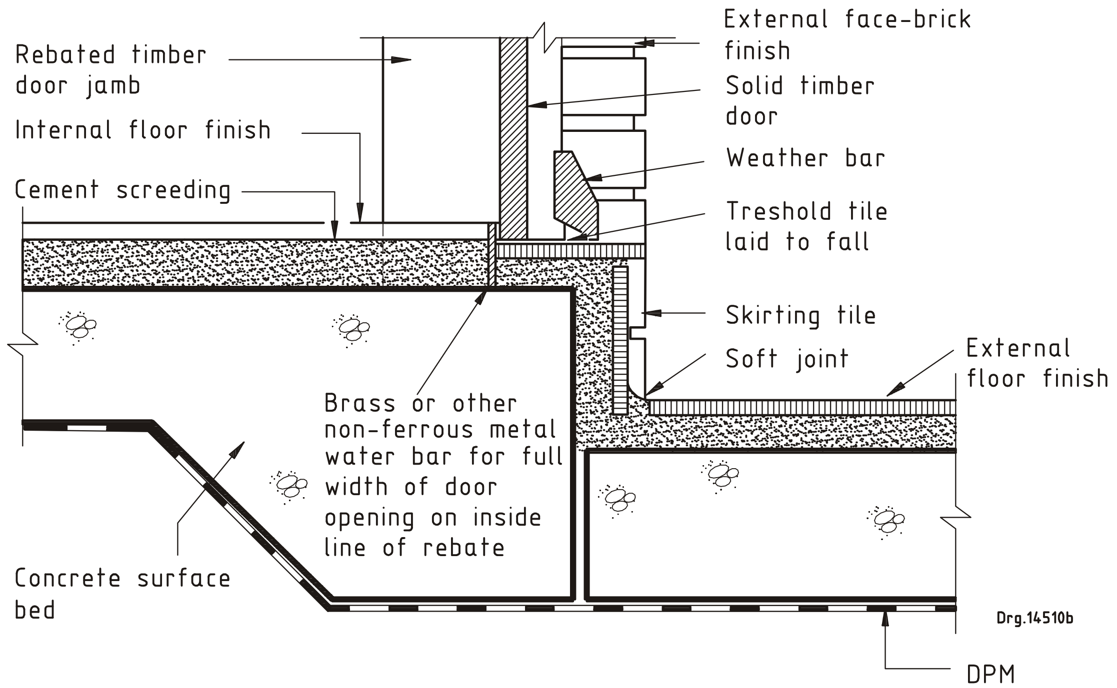


Figure 20 — Detail sections showing faulty bridging of DPCs and DPMs

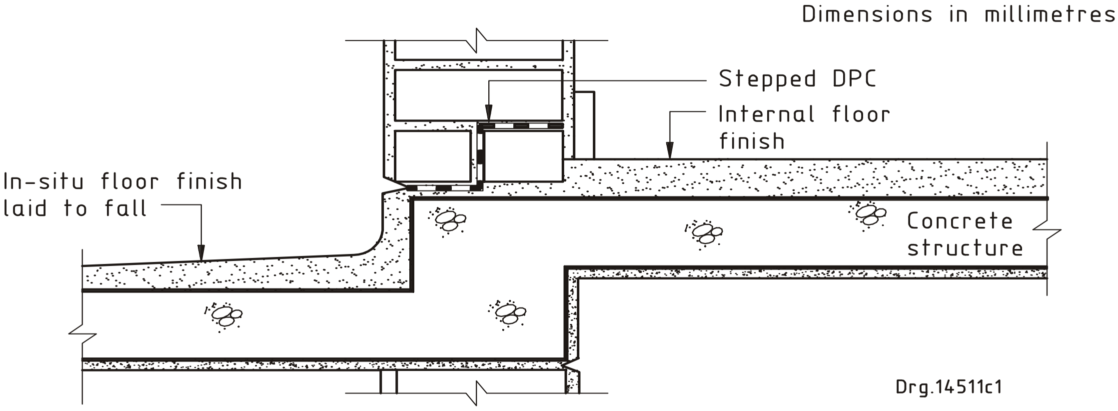


a) Example of door threshold (steel door jamb)

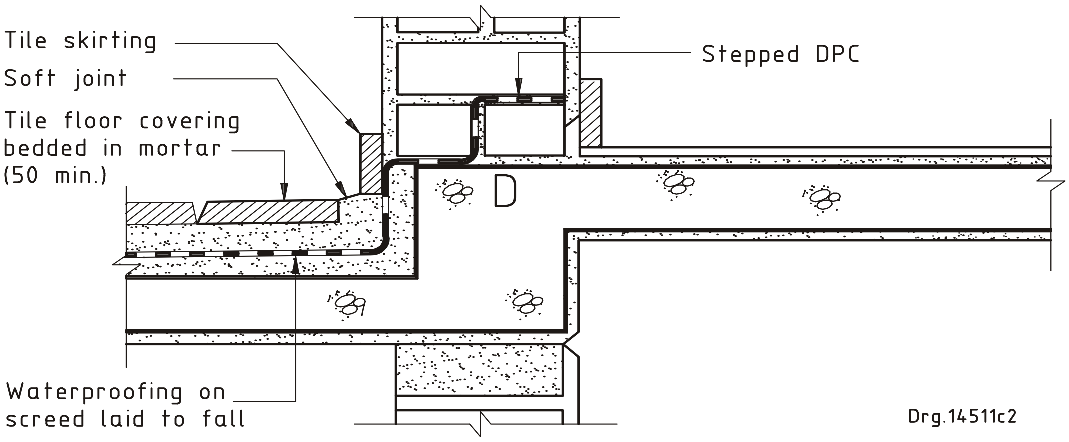


b) Example of door threshold with movement joint

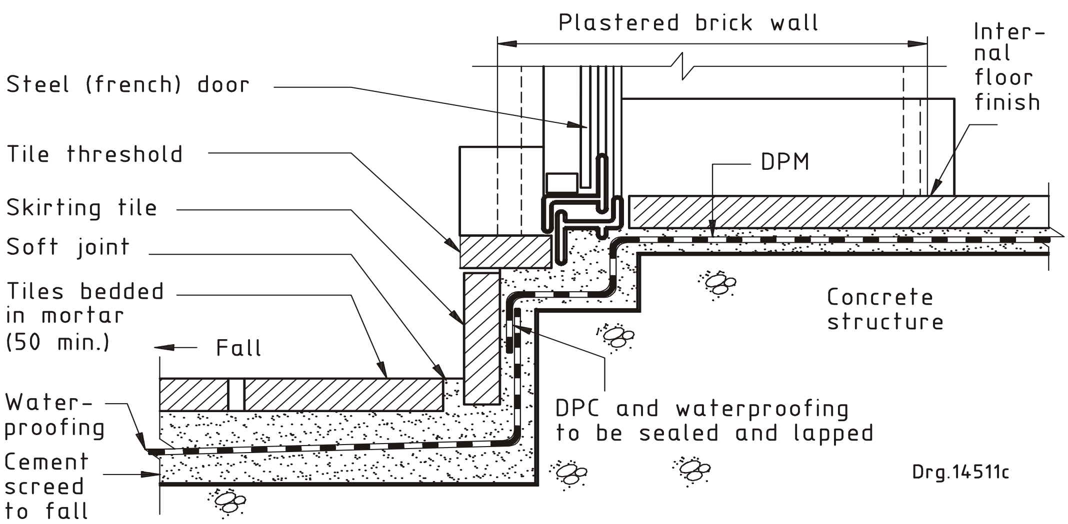
Figure 21 — Thresholds



a) Balcony floor with no waterproofing (dependant on concrete to resist moisture)



b) Waterproofing to balcony floor



c) Detail at "D" where door opens onto balcony (see figure (b) above)

Figure 22 — Balcony floor adjoining main building

Dimensions in millimetres

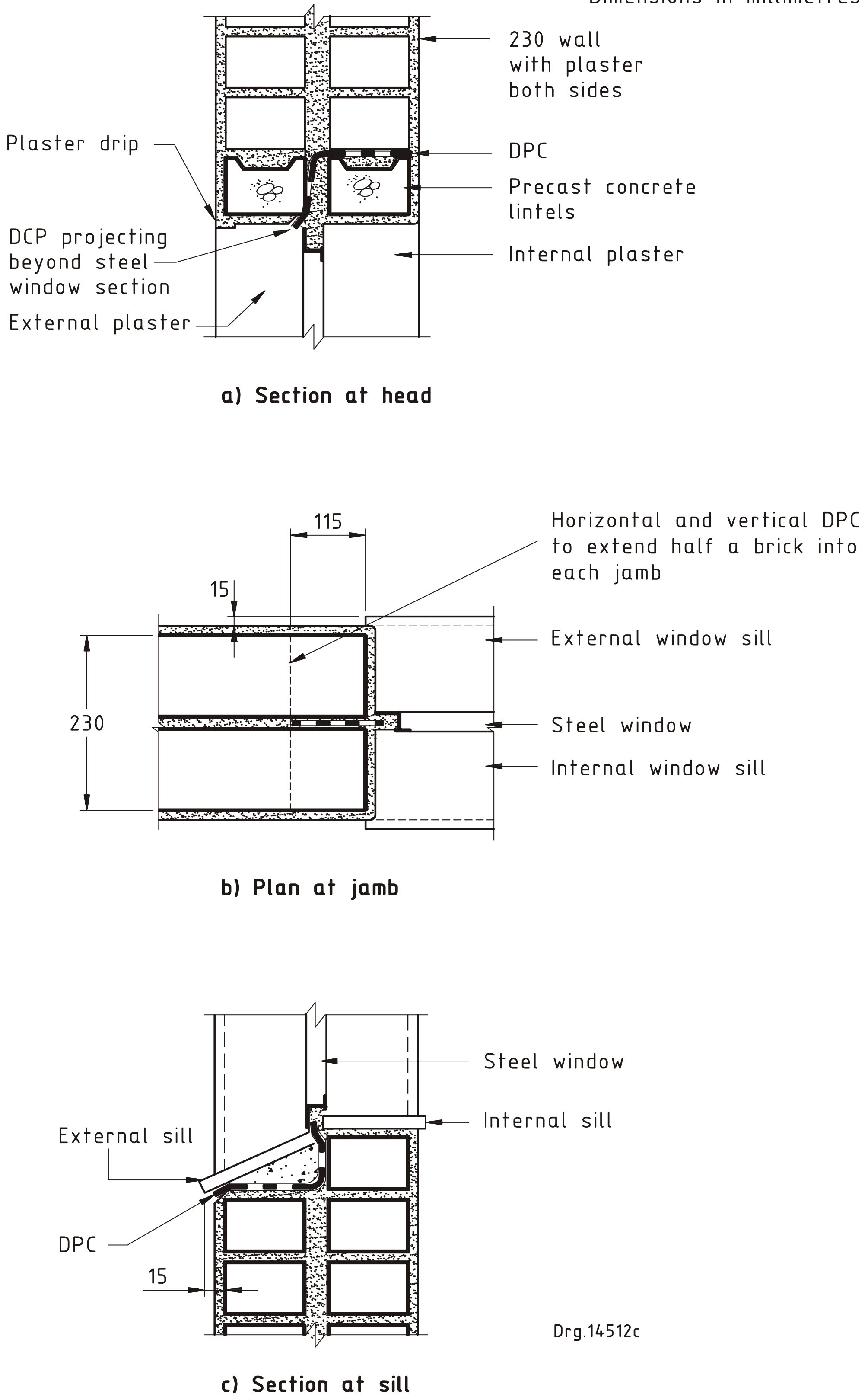


Figure 23 — DPC at steel windows in 230 mm solid wall, plastered both sides

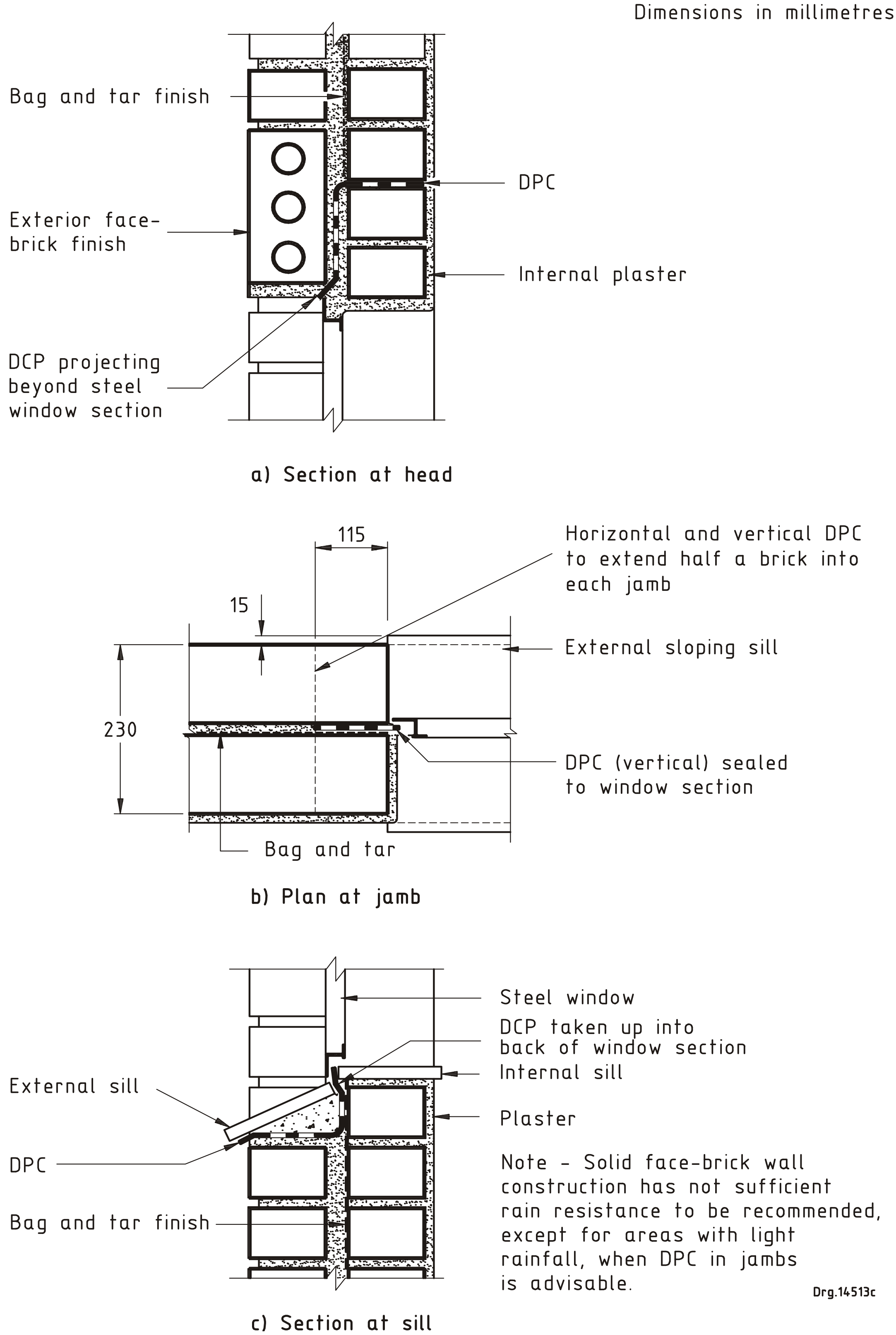
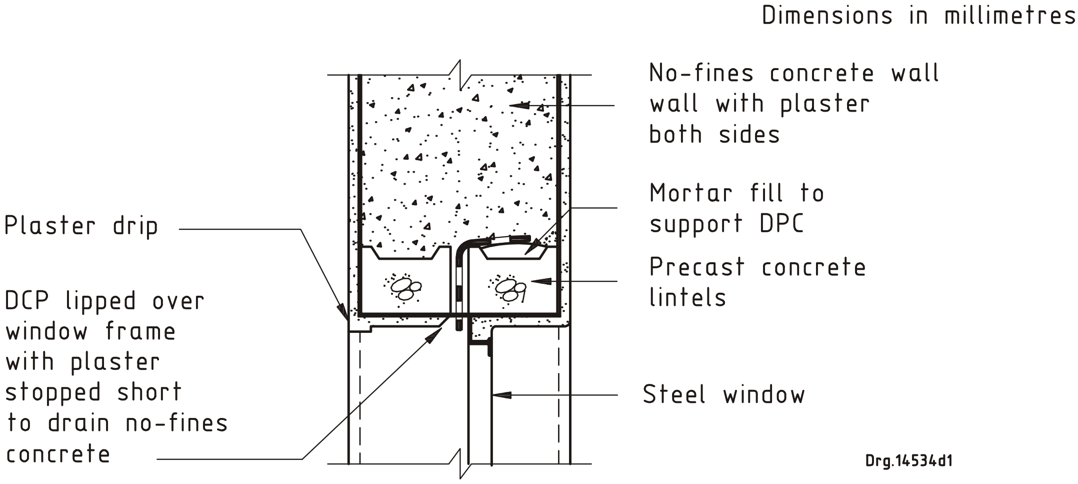
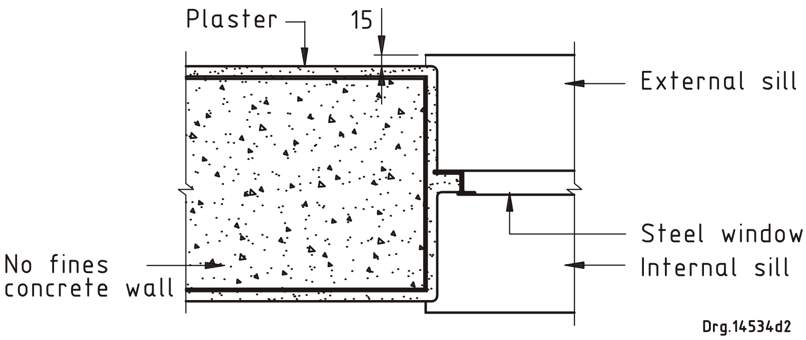


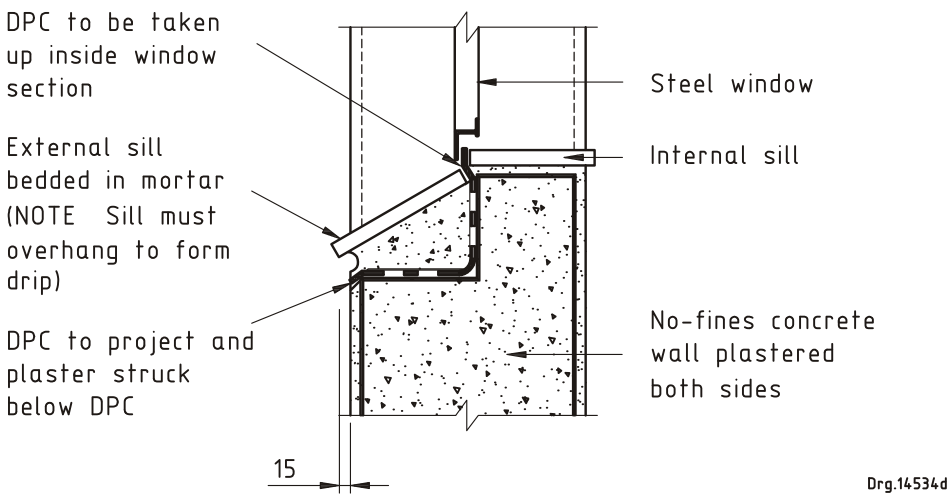
Figure 24 — DPC at steel windows in 230 mm solid wall, face-brick externally



a) Section at head



b) Plan at jamb



c) Section at sill

Figure 25 — Typical waterproofing details at window openings in no-fines concrete wall — Conventional details

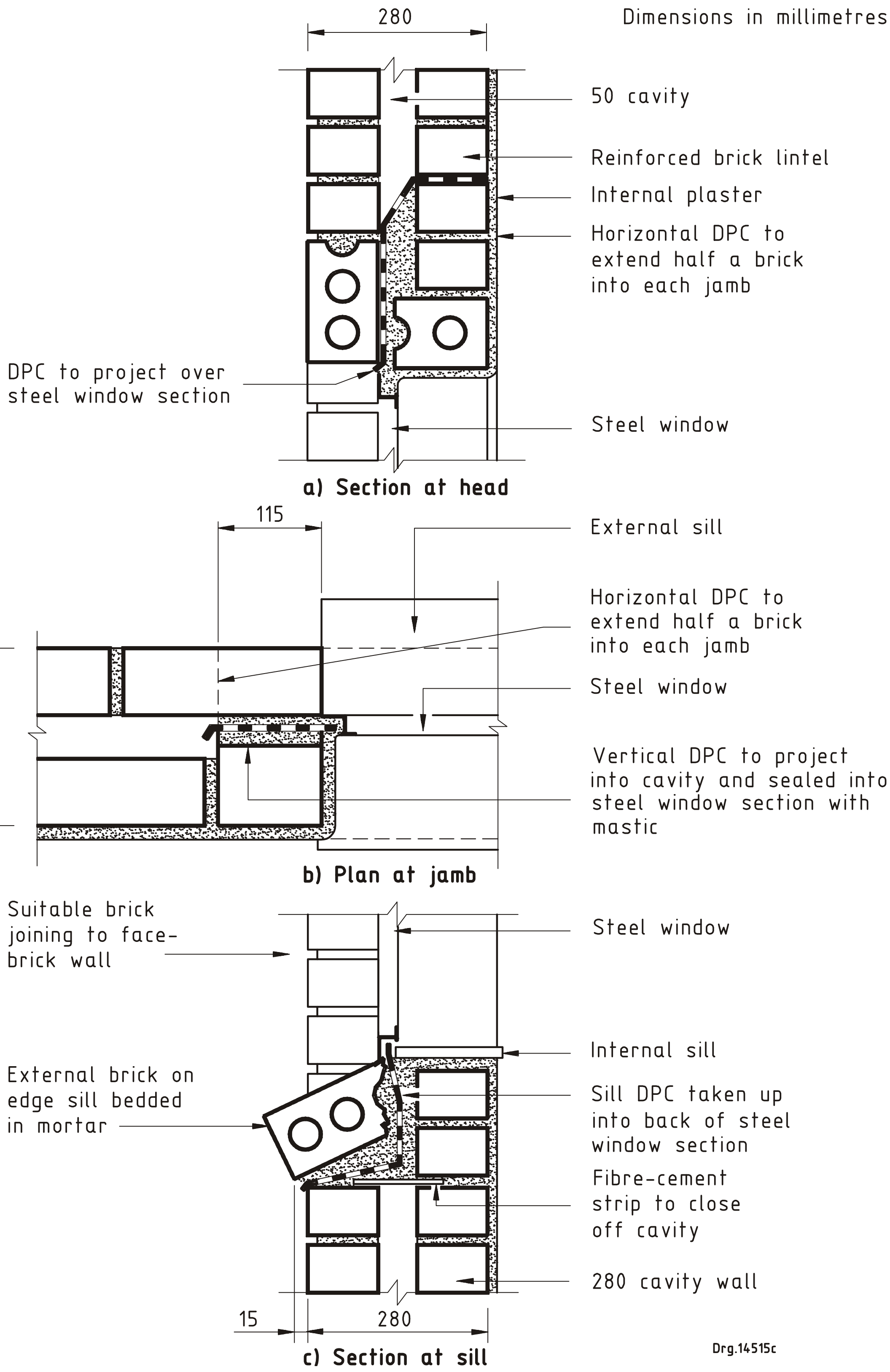


Figure 26 — Typical waterproofing details at window openings in no-fines concrete wall with precast sill and lintel

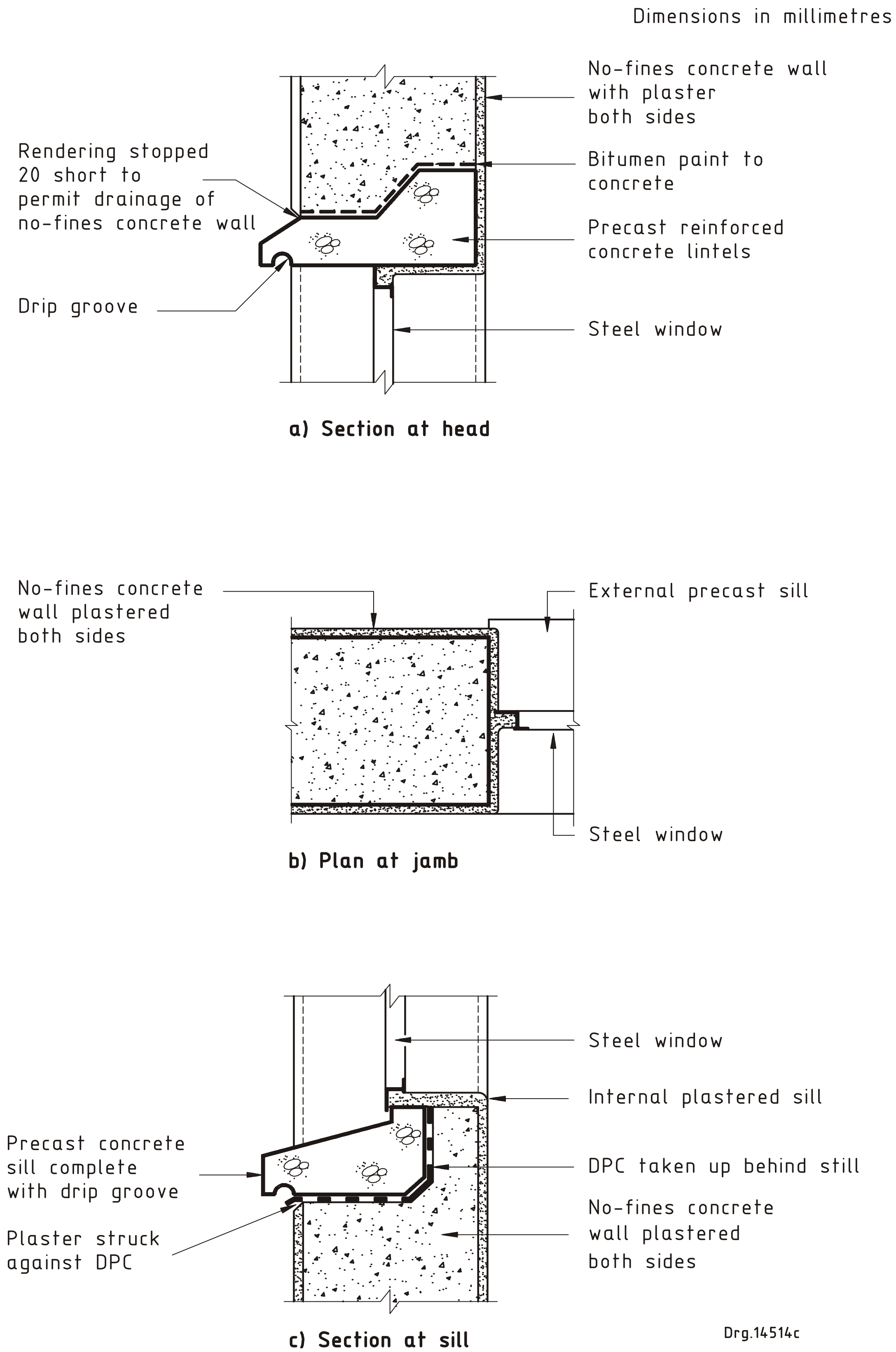


Figure 27 — Typical waterproofing details at window openings in cavity brick wall

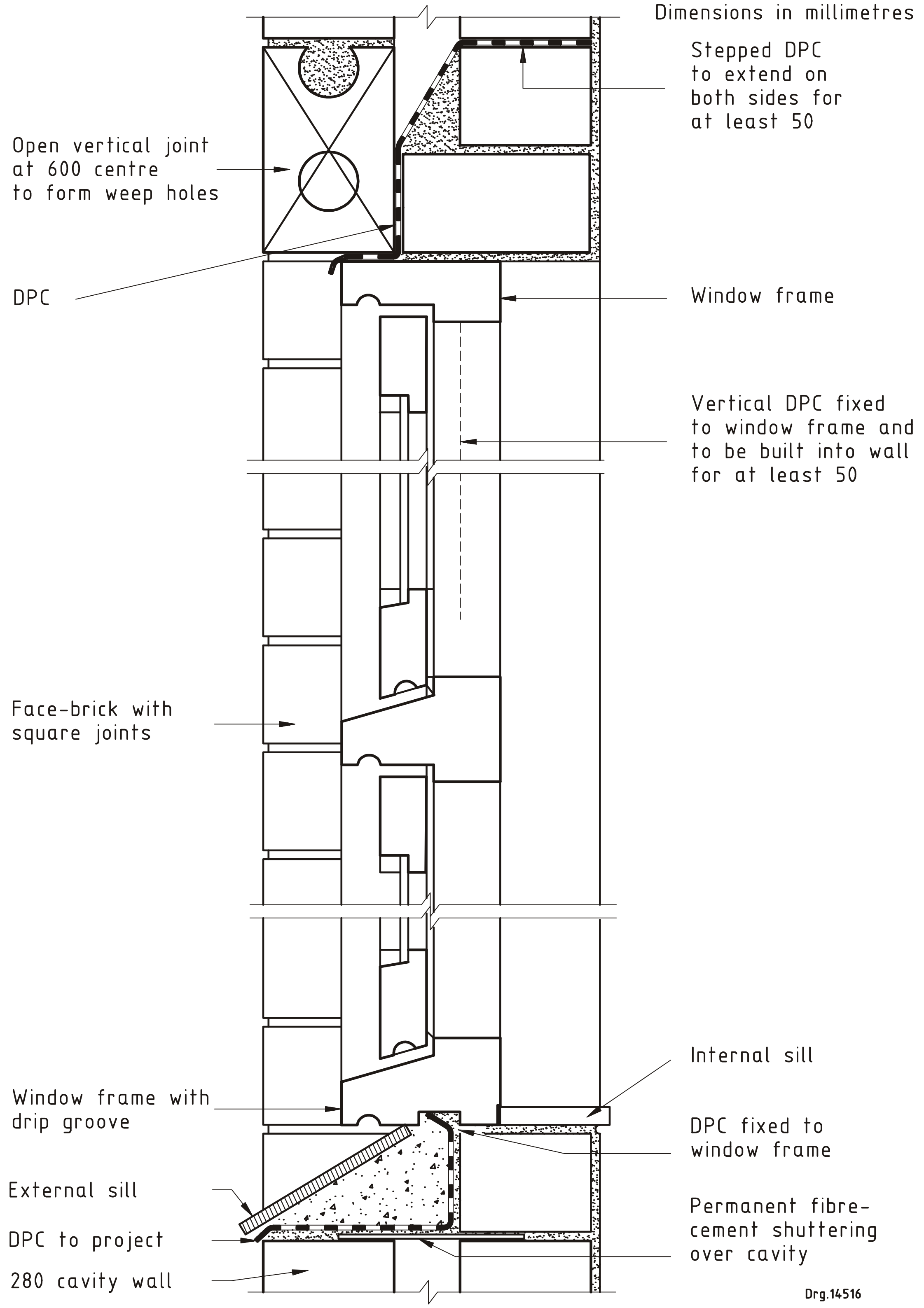


Figure 28 — DPC at timber window frame in cavity brick wall

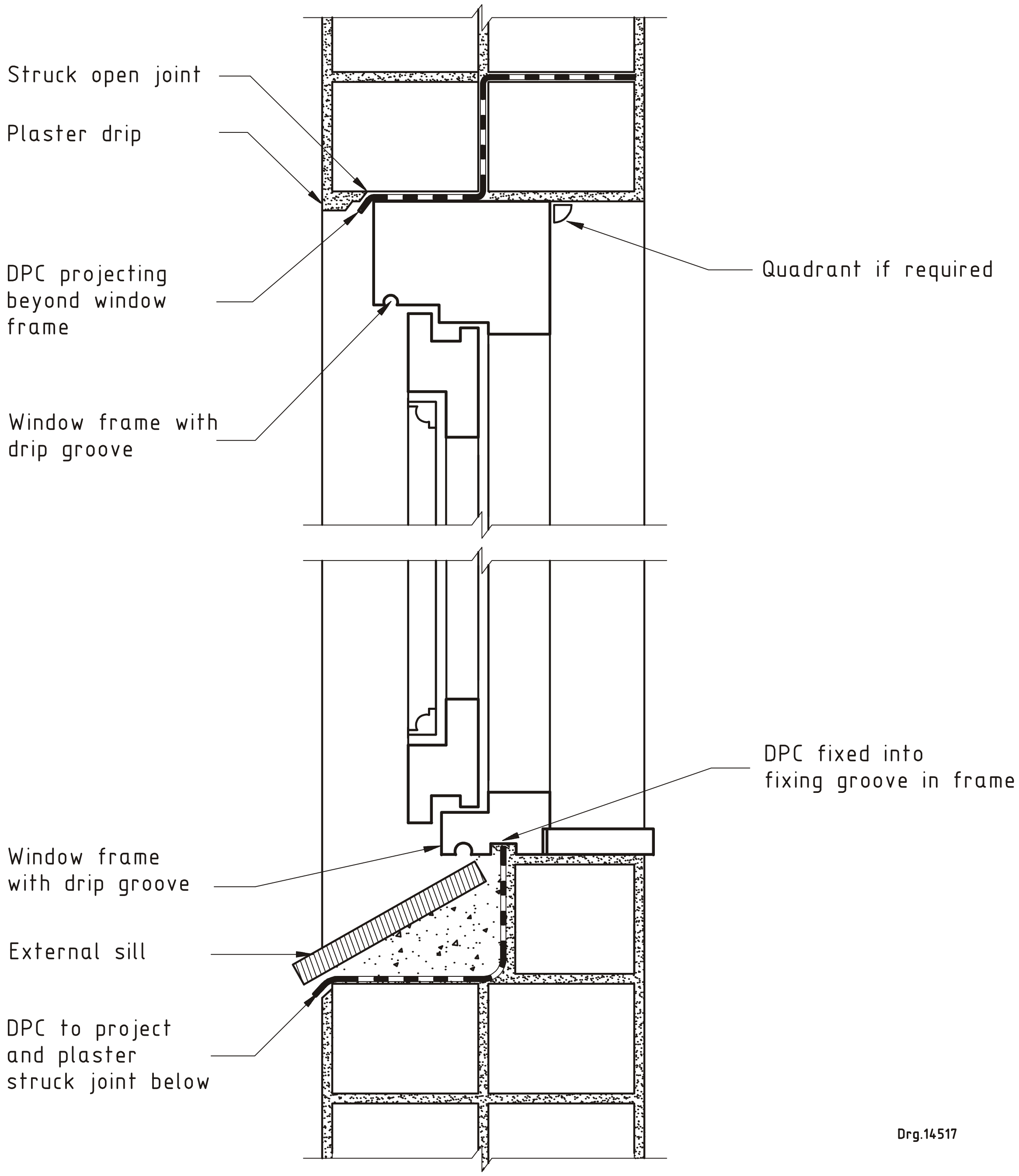


Figure 29 — DPC at timber windows in 230 mm solid wall, plastered both sides

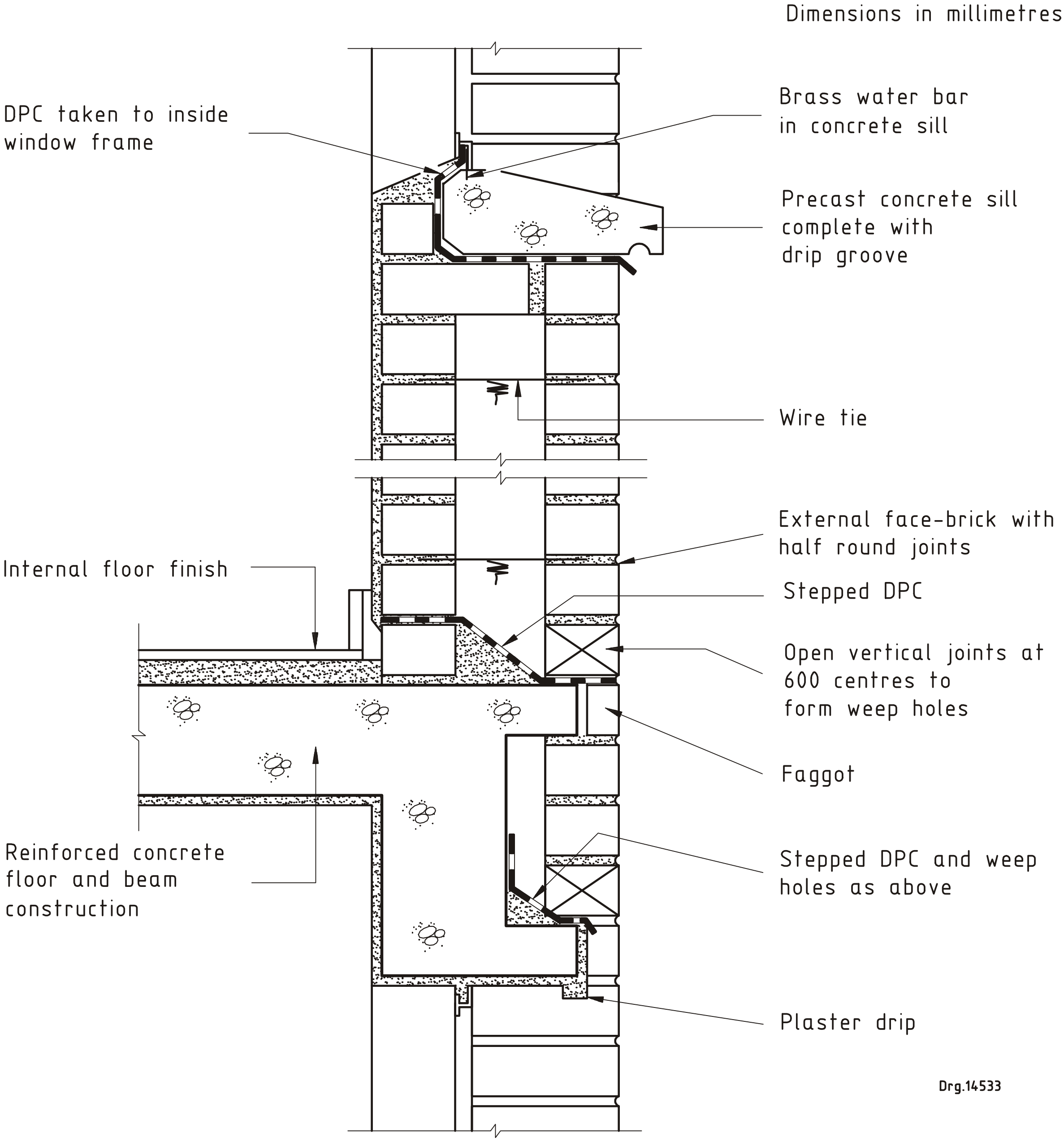


Figure 30 — DPCs in multi-storey construction with cavity wall

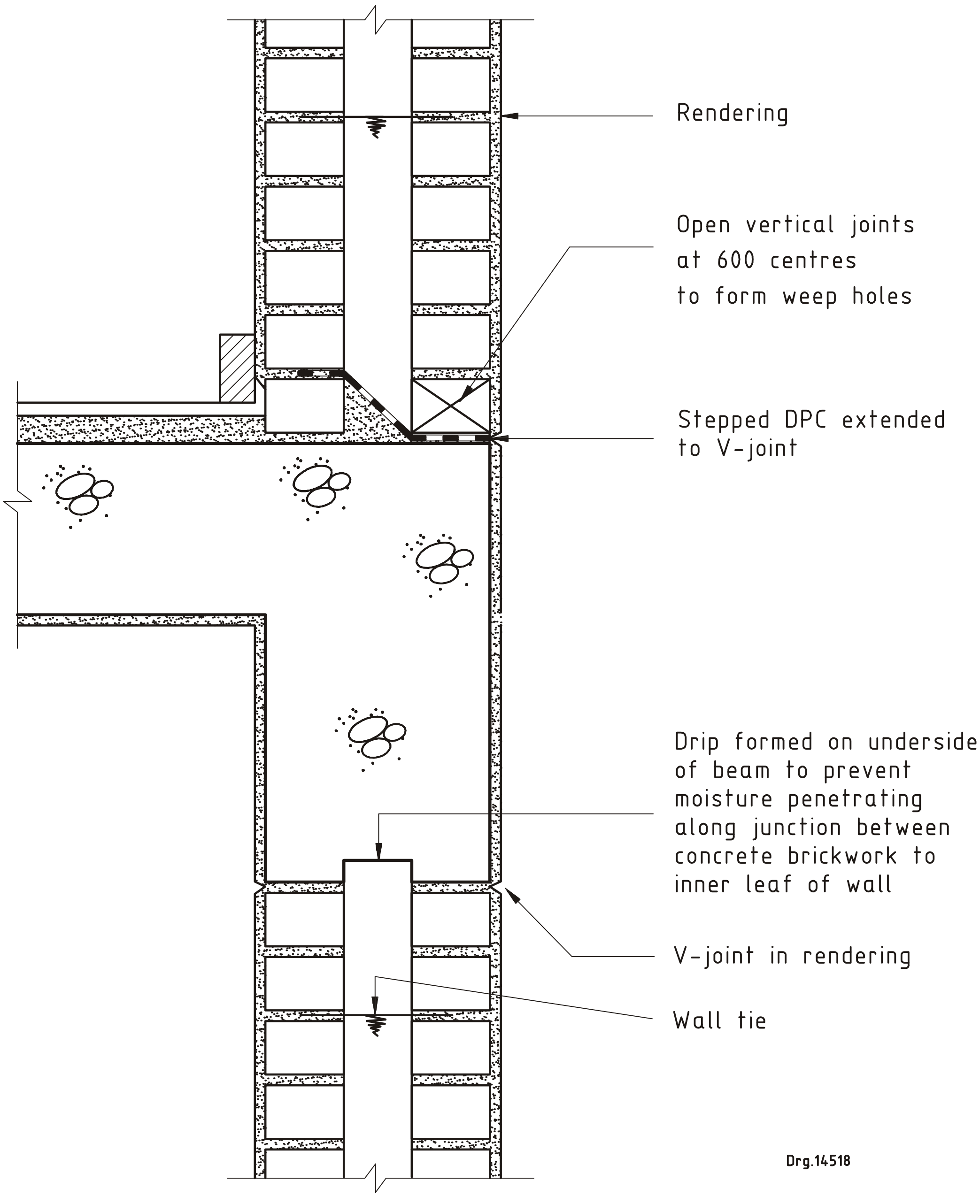


Figure 31 — Rendered cavity wall in multi-storey construction

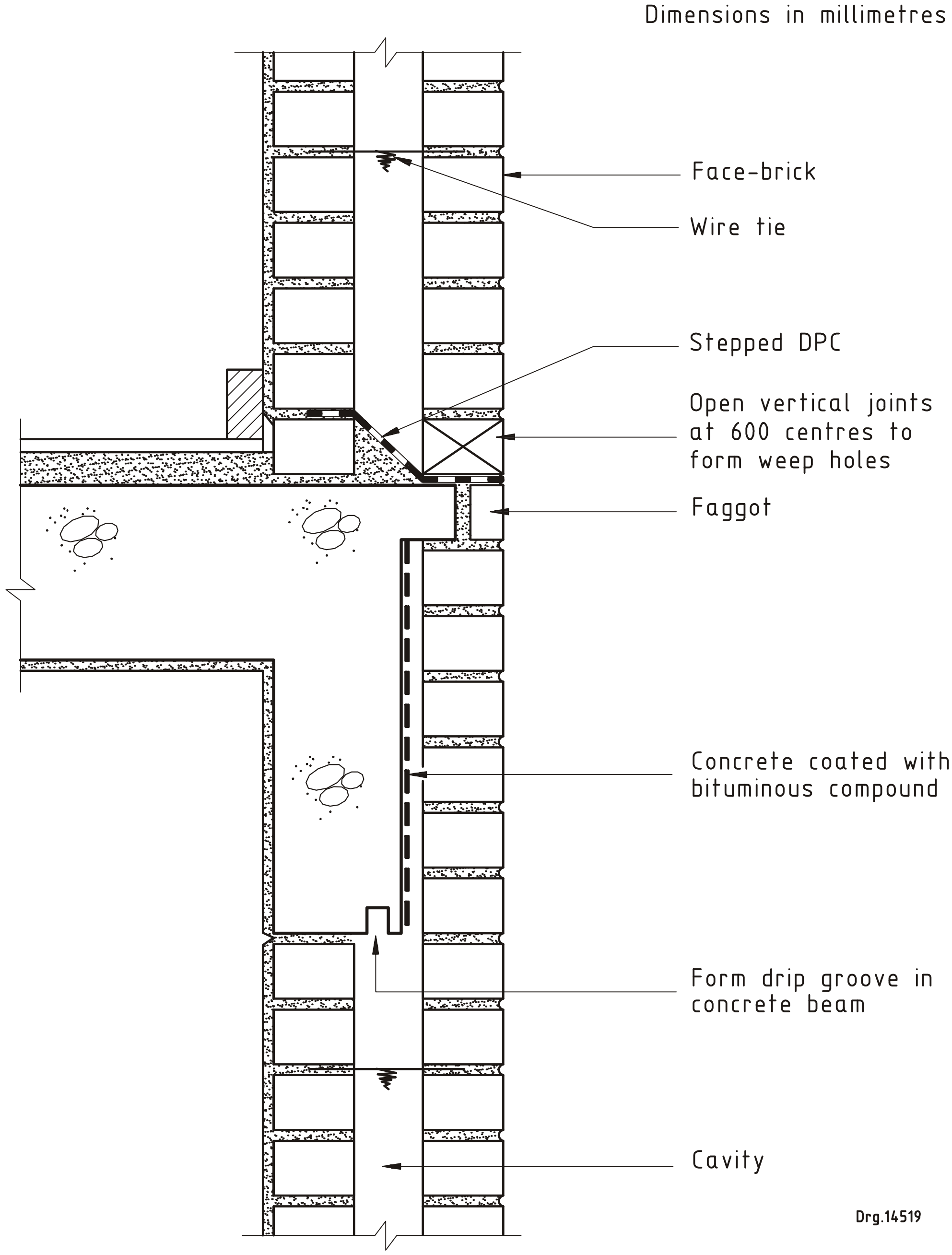
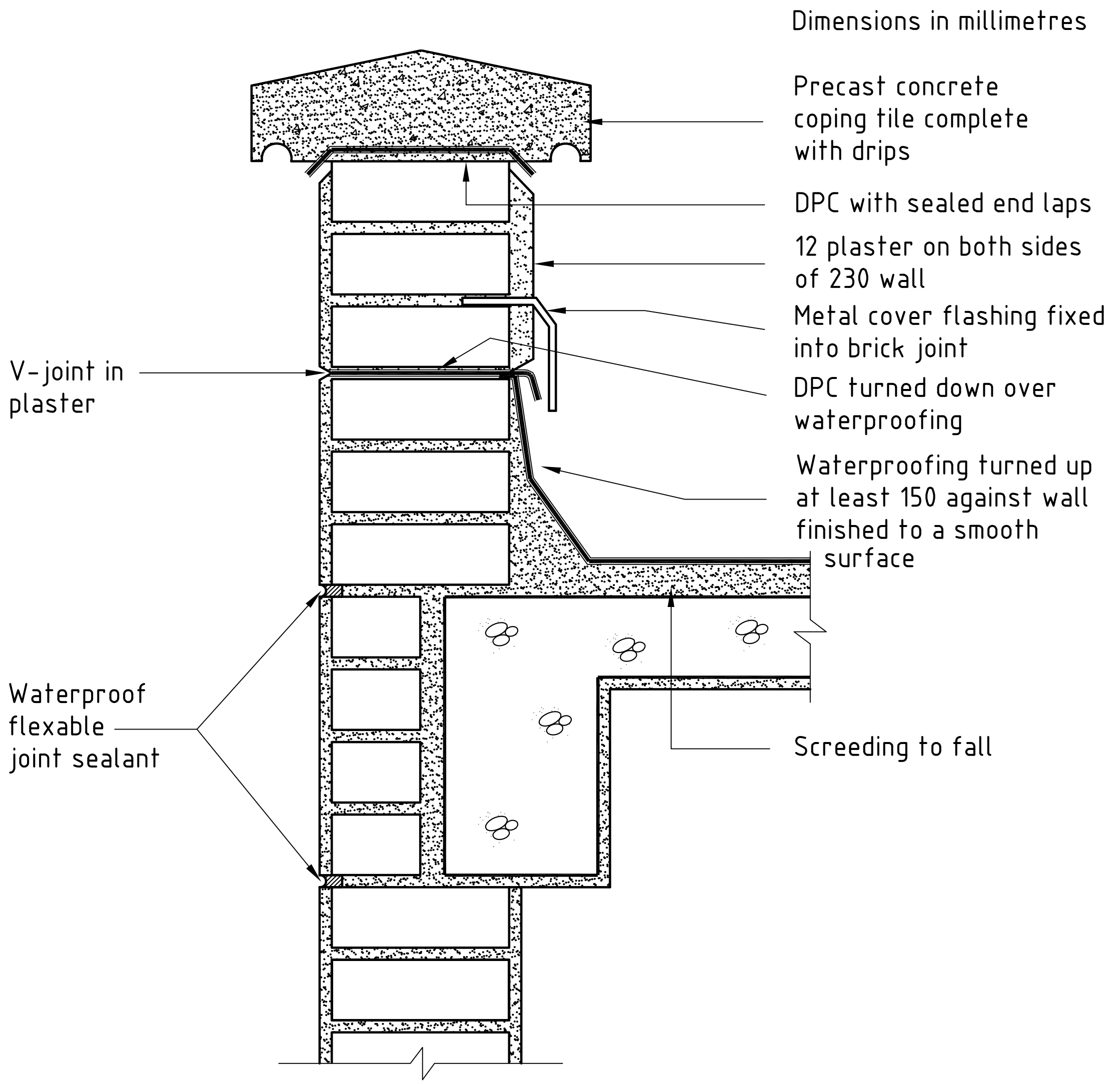
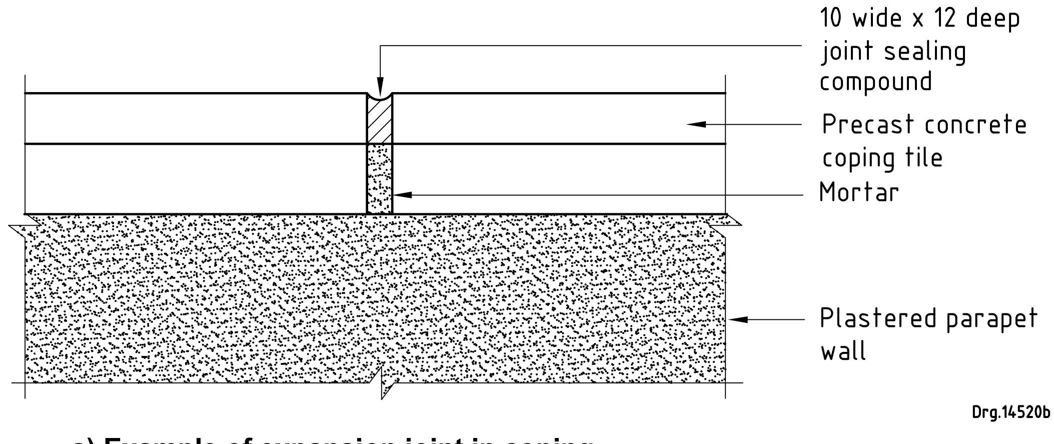


Figure 32 — Cavity wall in multi-storey construction, suitable for coastal areas



a) Example of solid parapet wall construction



a) Example of expansion joint in coping

Figure 33 — Waterproofing at solid parapet walls

Dimensions in millimetres

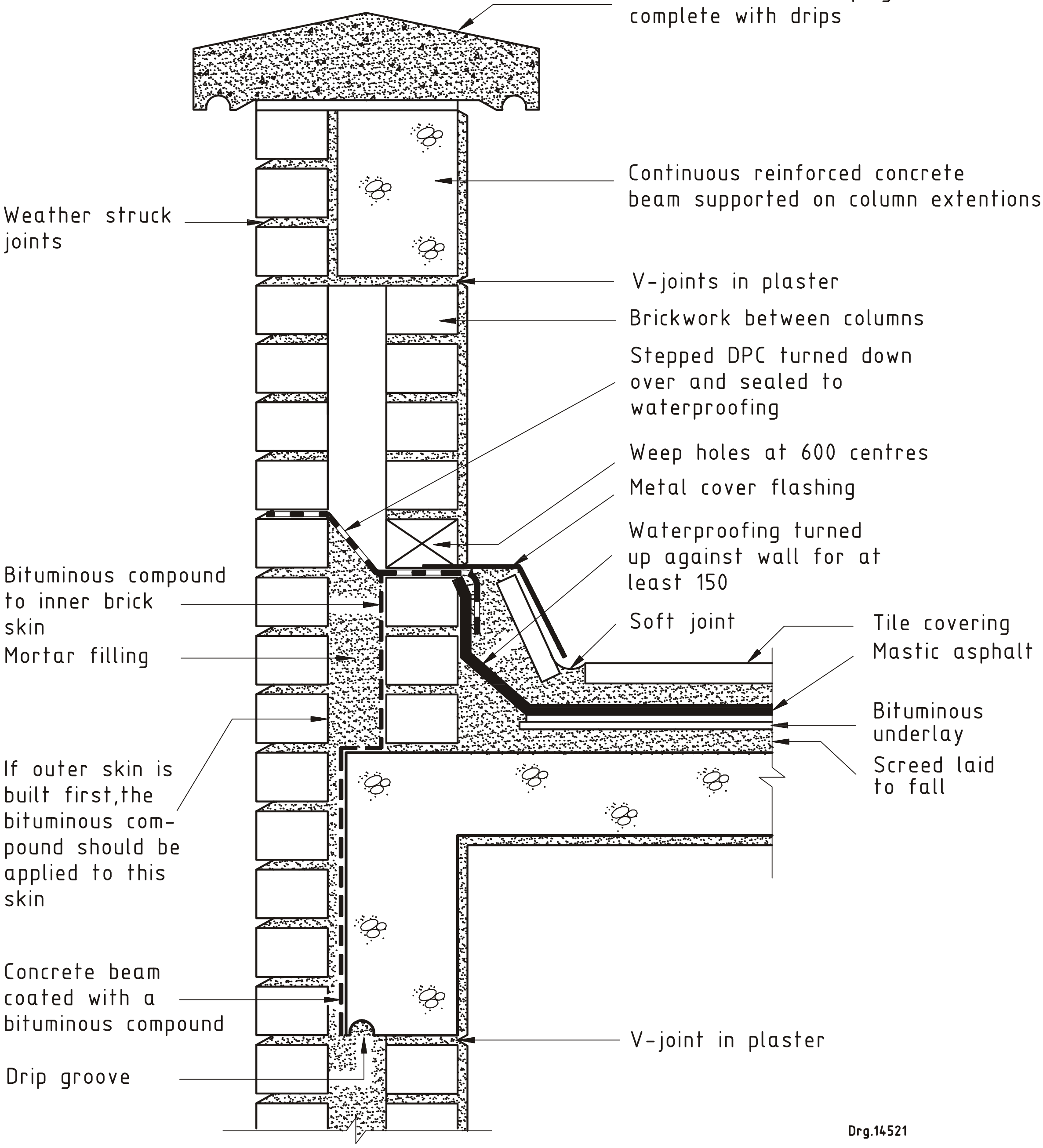


Figure 34 — Cavity parapet wall with ring beam to limit differential movement

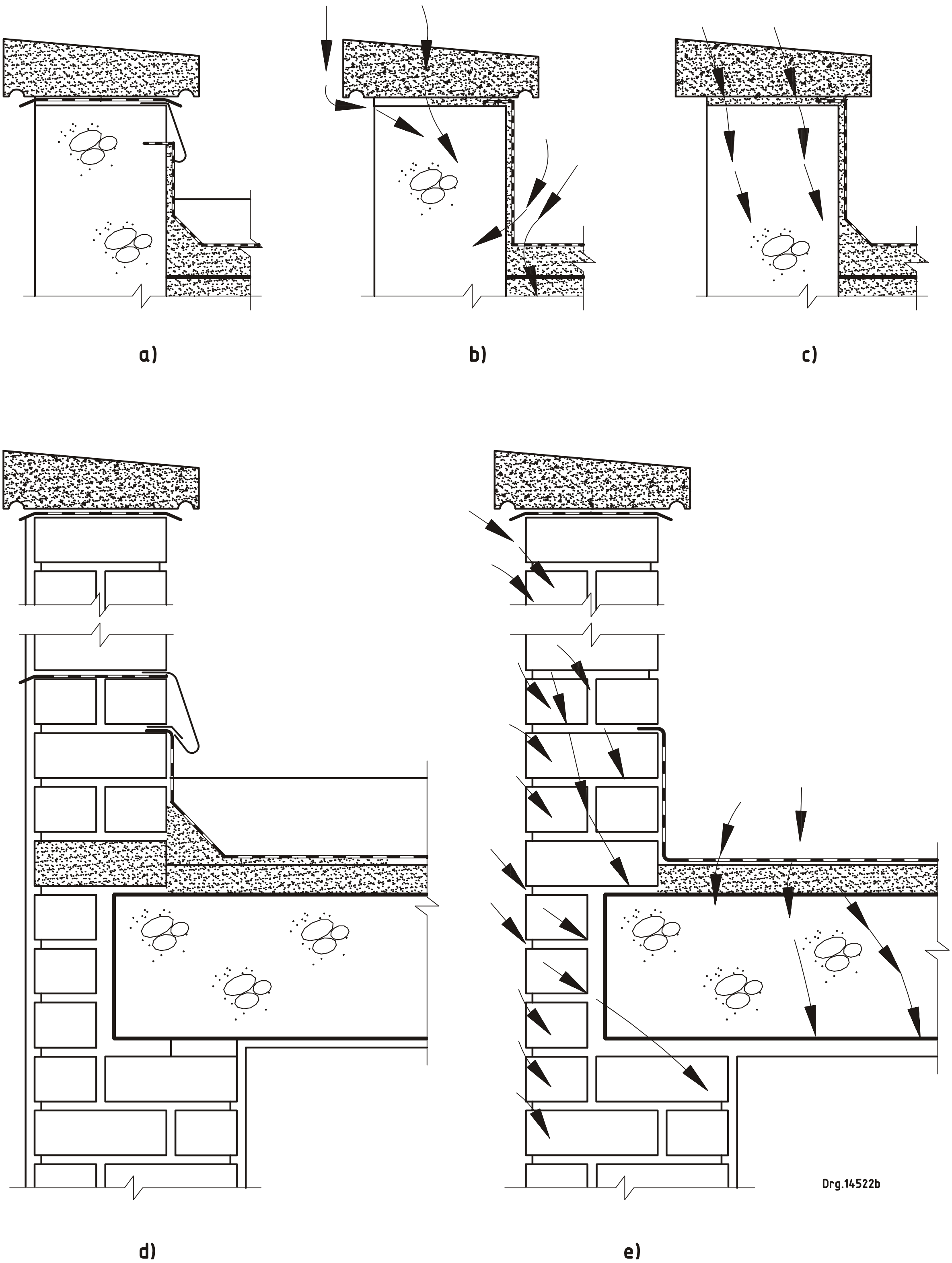


Figure 35 — Waterproofing of parapets, including copings in solid 230 mm masonry wall

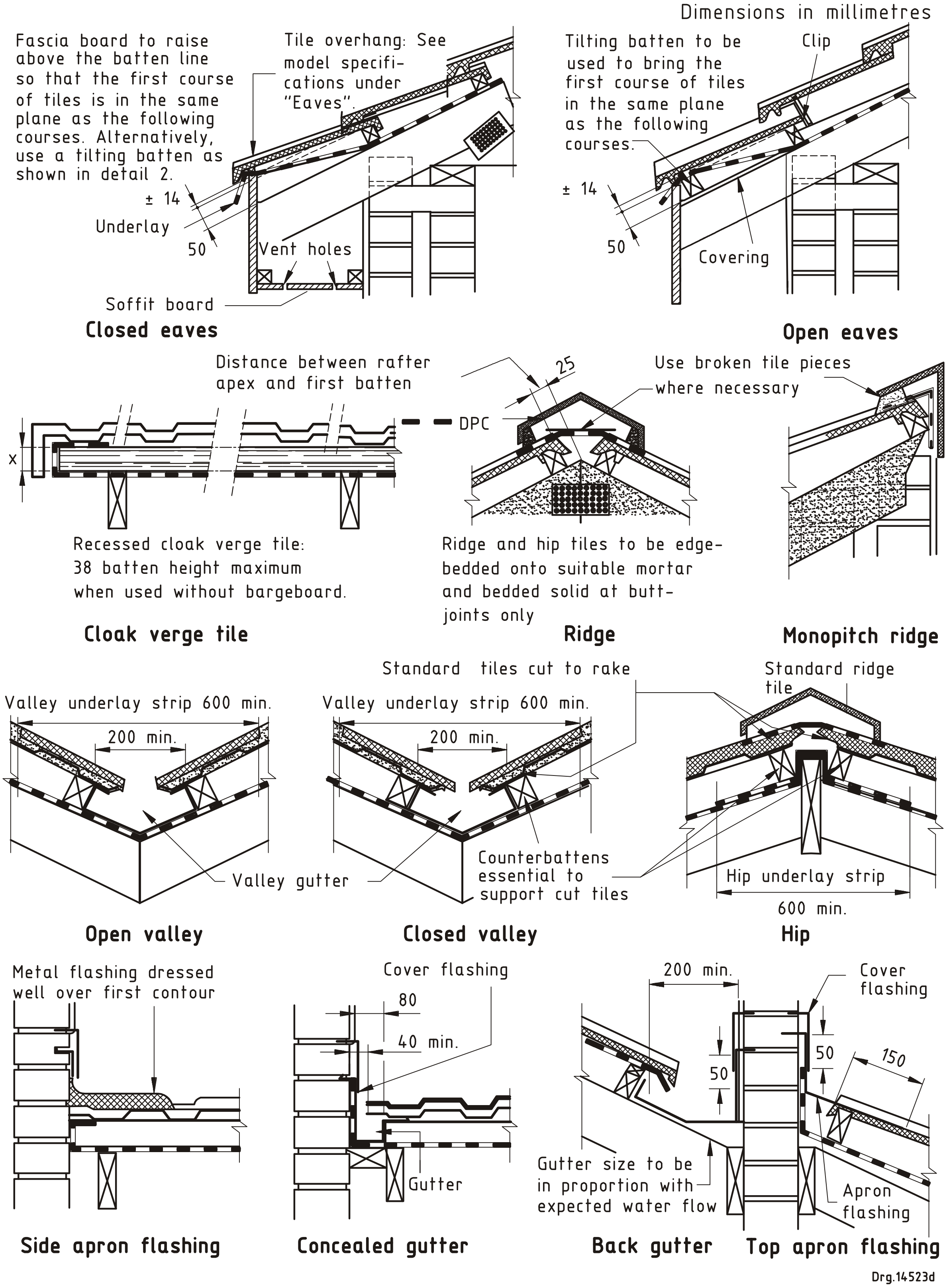


Figure 36 — Typical roof tile details

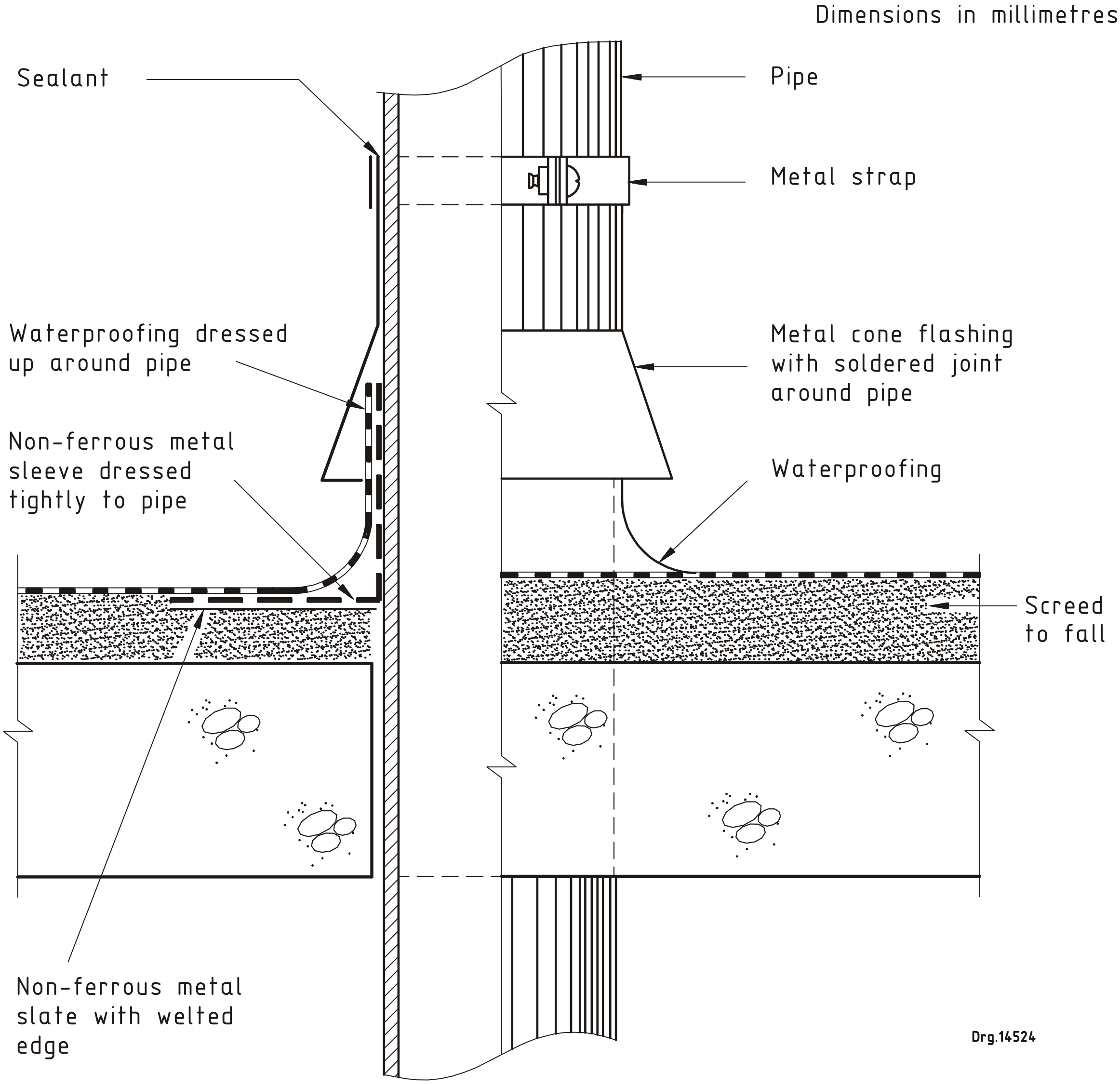
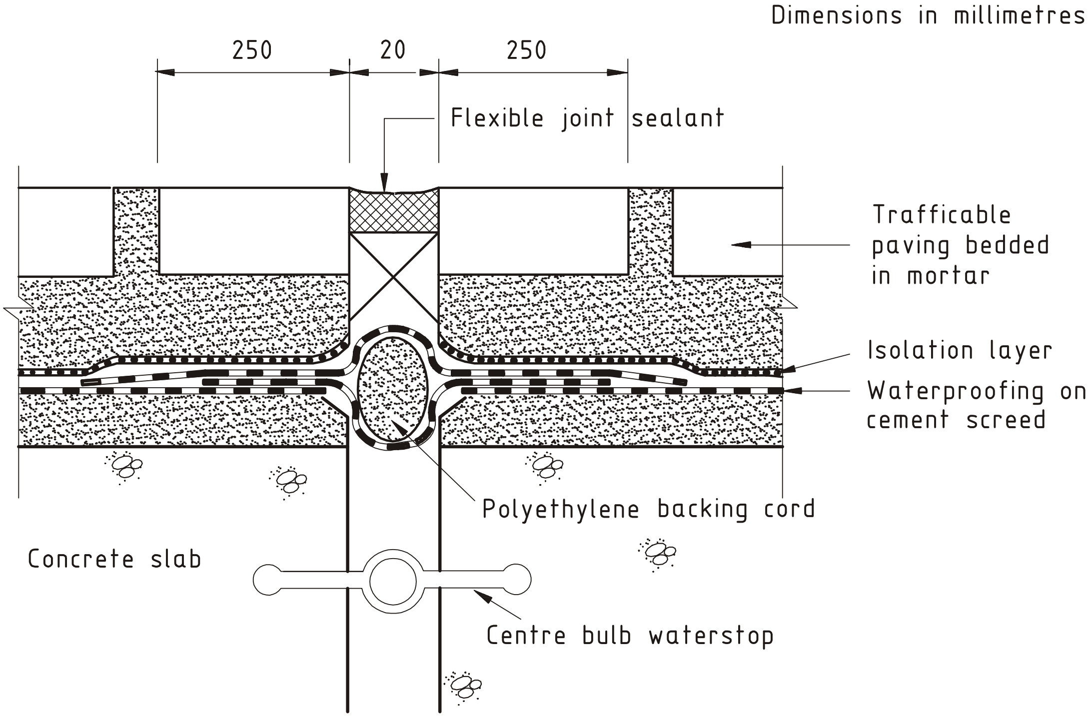
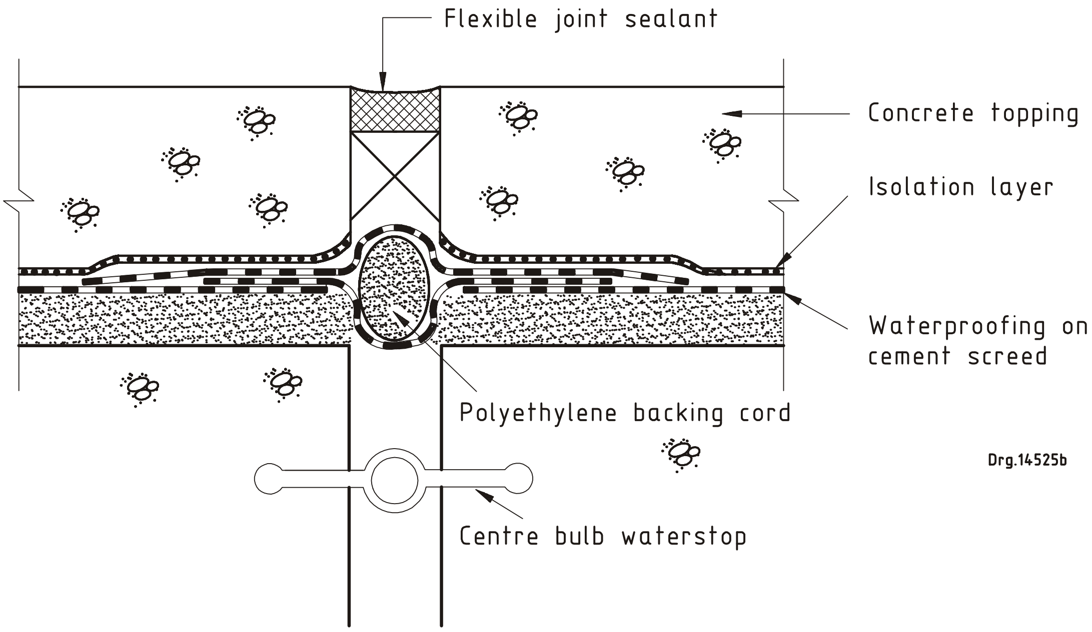


Figure 37 — Waterproofing around pipe through flat roof using protective metal cone



a) Pedestrian trafficable deck joint



b) Light-vehicle trafficable deck joint

Figure 38 — External expansion joints

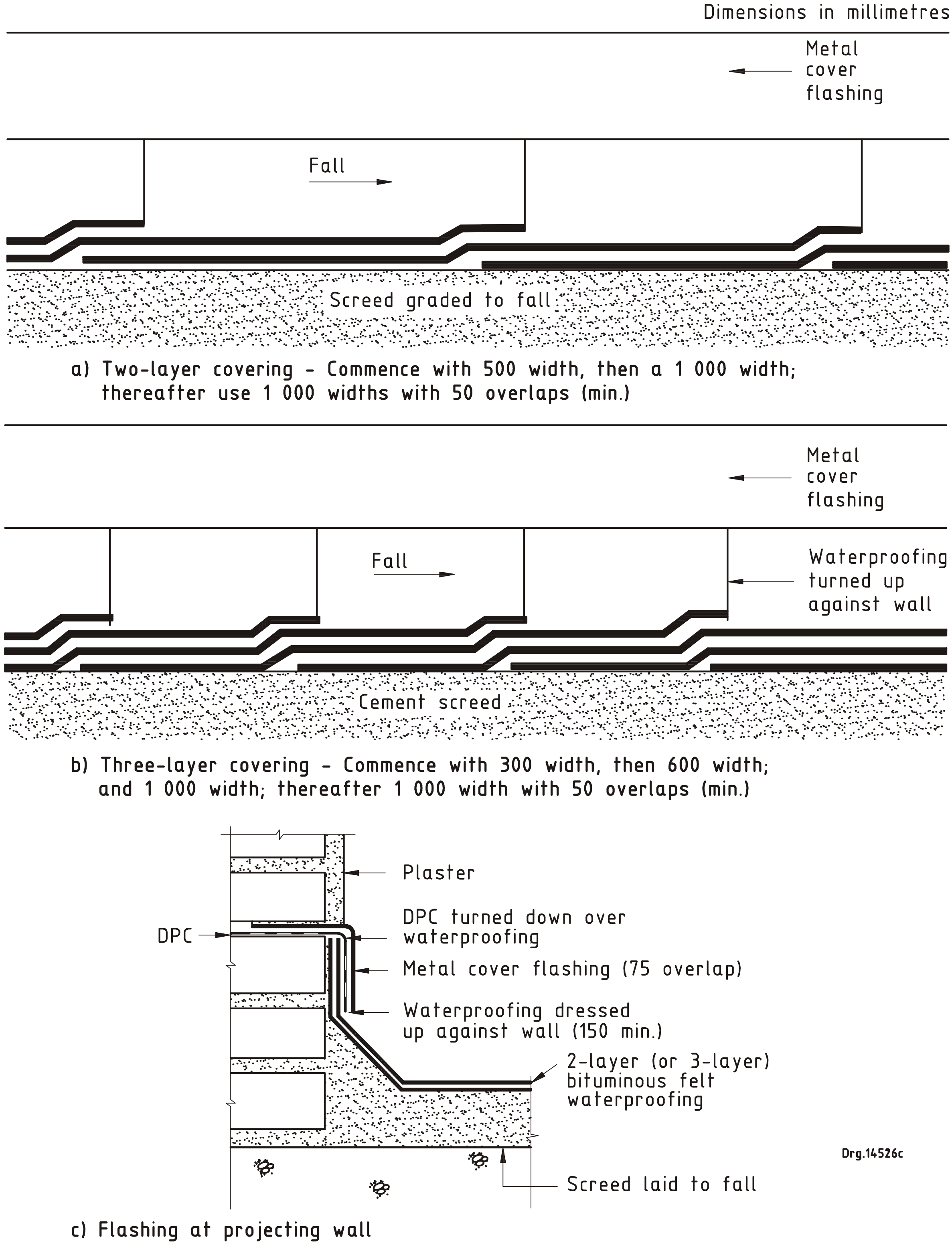
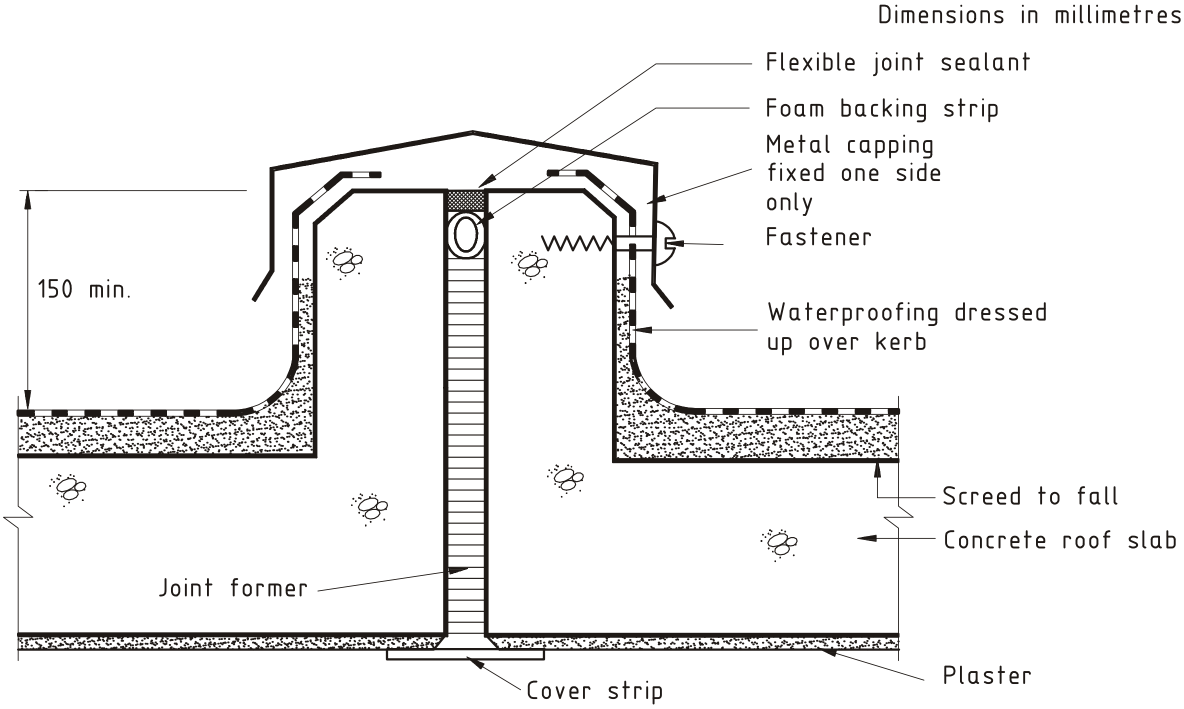
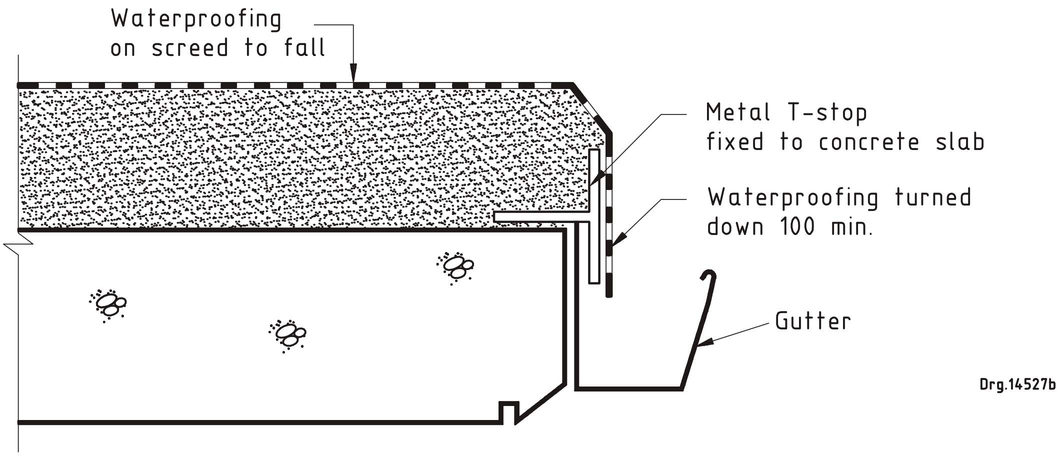


Figure 39 — Shingle method of lapping bituminous felt on flat roofs, basement floors and walls



a) Example of expansion joint with raised kerb



b) Example of fascia detail

Figure 40 — Flat roof waterproofing details

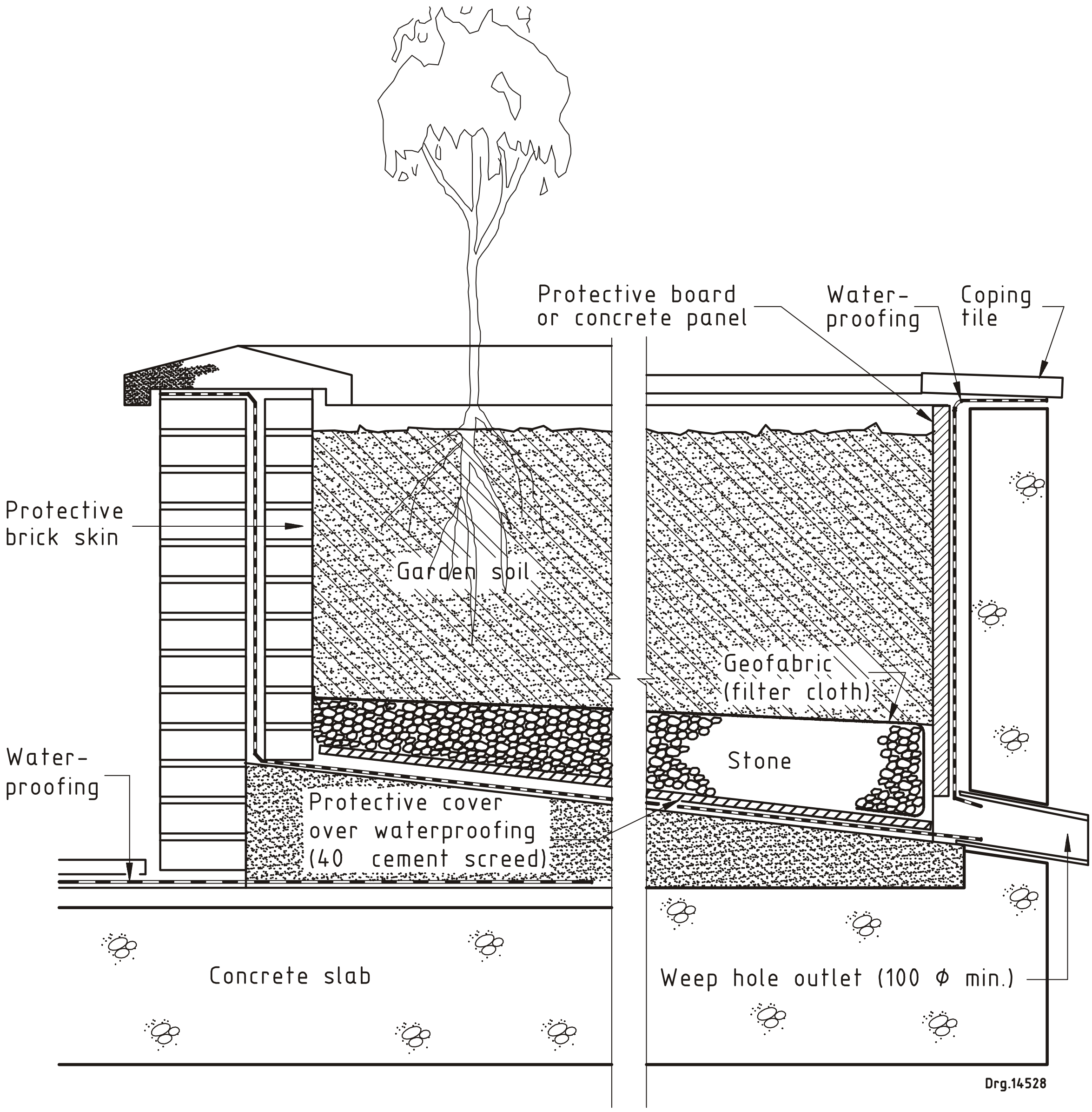


Figure 41 — Roof garden and planter details

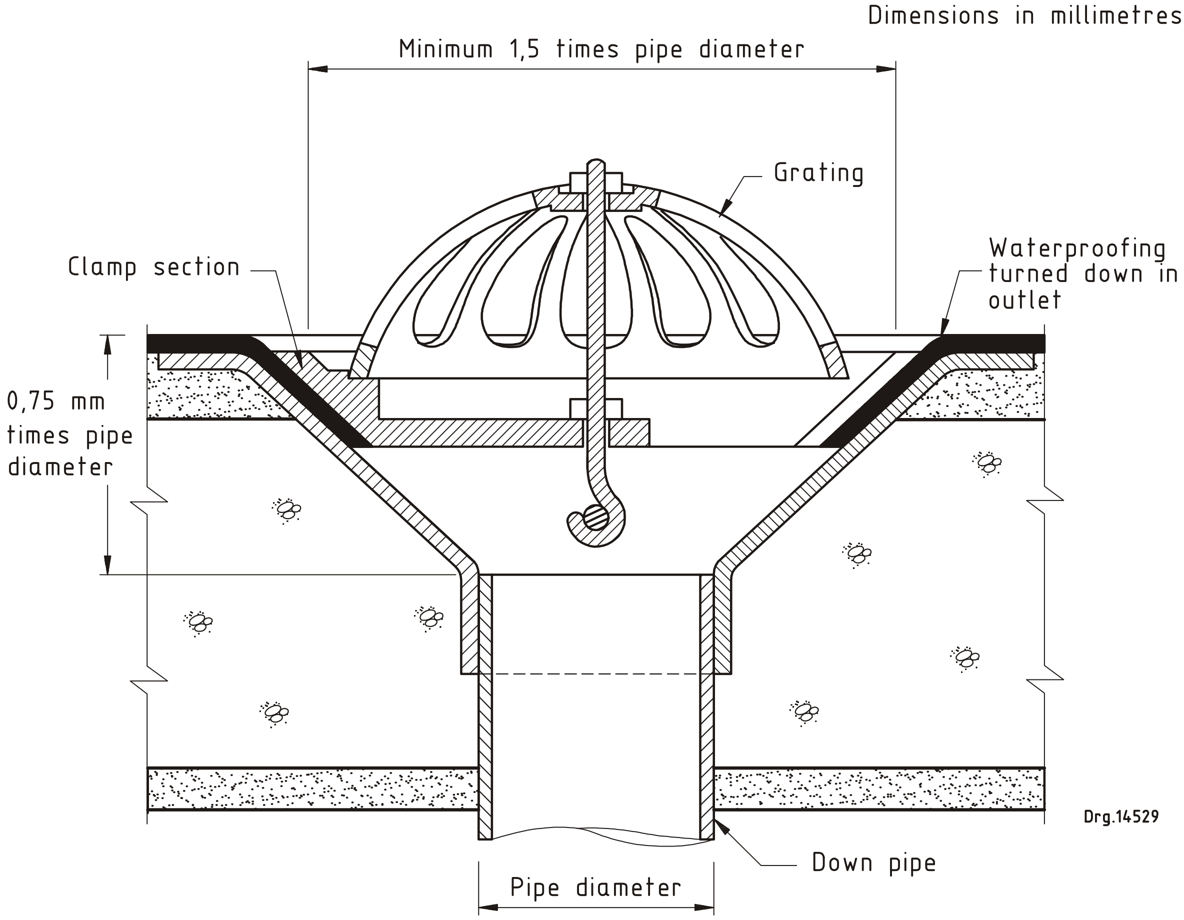
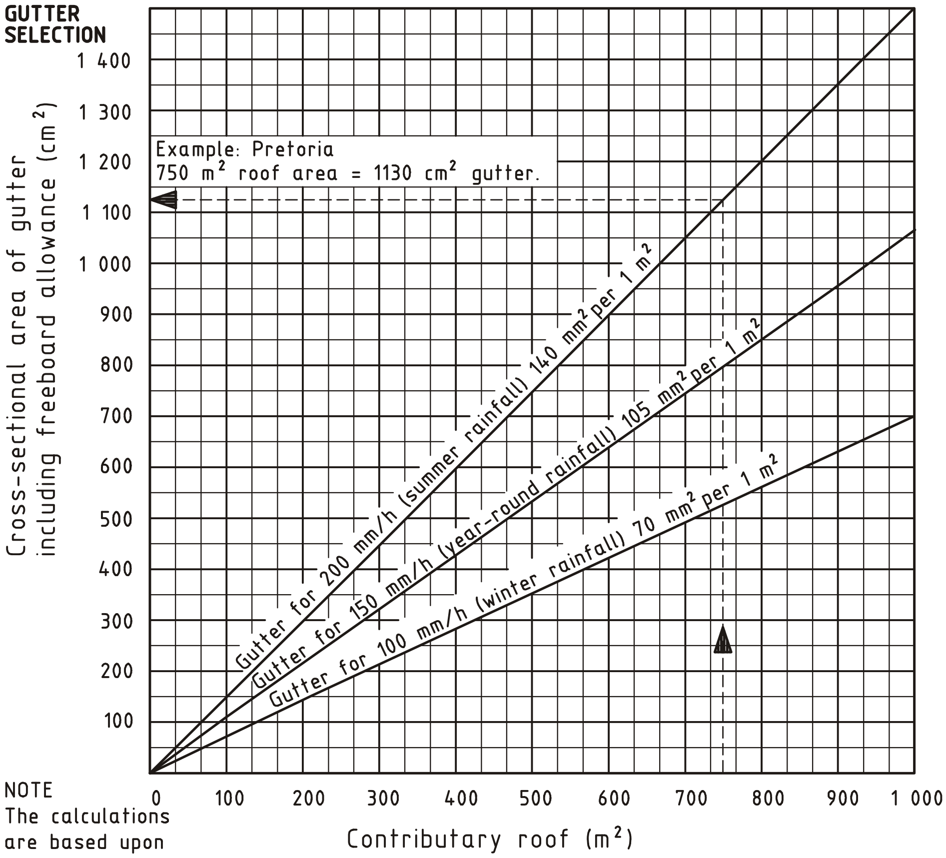


Figure 42 — Storm and surface water outlet through concrete roof (proprietary design)



NOTE
The calculations are based upon the rain intensity for a period of 5 minutes.

The depth of a rectangular gutter should be between 1/2 and 1/3 of the width.

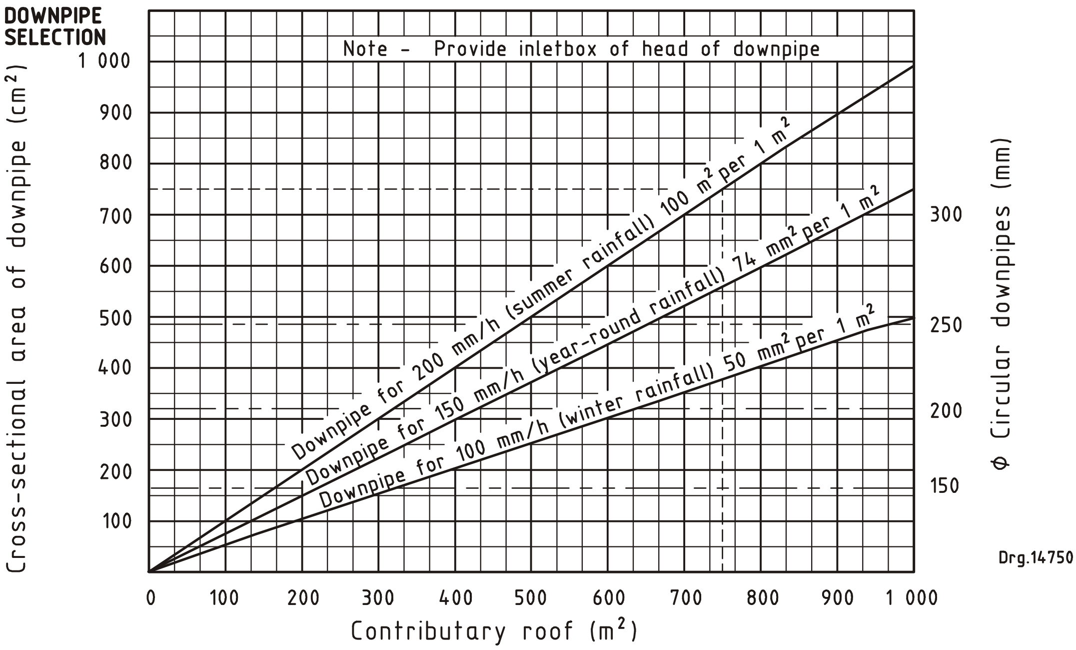


Figure 43 — Gutter and downpipe selection chart

Annex A Deleted by amendment No. 2

Annex B
(informative)

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Amdt 3

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SANS 1491-2, *Portland cement extenders – Part 2: Fly ash*.

SANS 1491-3, *Portland cement extenders – Part 3: Silica fume.*

SANS 50197-2/EN 197-2, *Cement – Part 2: Conformity evaluation.* **Amdt 1**

SANS 50413-2/EN 413-2, *Masonry cement – Part 2: Test methods.*
Amdt 1; amdt 2

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